ROBUST SYSTEMS IN SUSTAINABLE ORGANISATIONS

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Kevan G Leach has over forty years' experience in food industry operations in the UK, USA, Europe, and Japan. He taught Deming principles at degree and post degree level. He is also a Chartered Engineer and a Fellow of both the Institution of Mechanical Engineers and the Institution of Engineering and Technology.

LEARNING ORGANISATIONS:

The learning organisation deploys strategies that connect customer, people within the organisation, suppliers and learning to engage in collective and collaborative working.

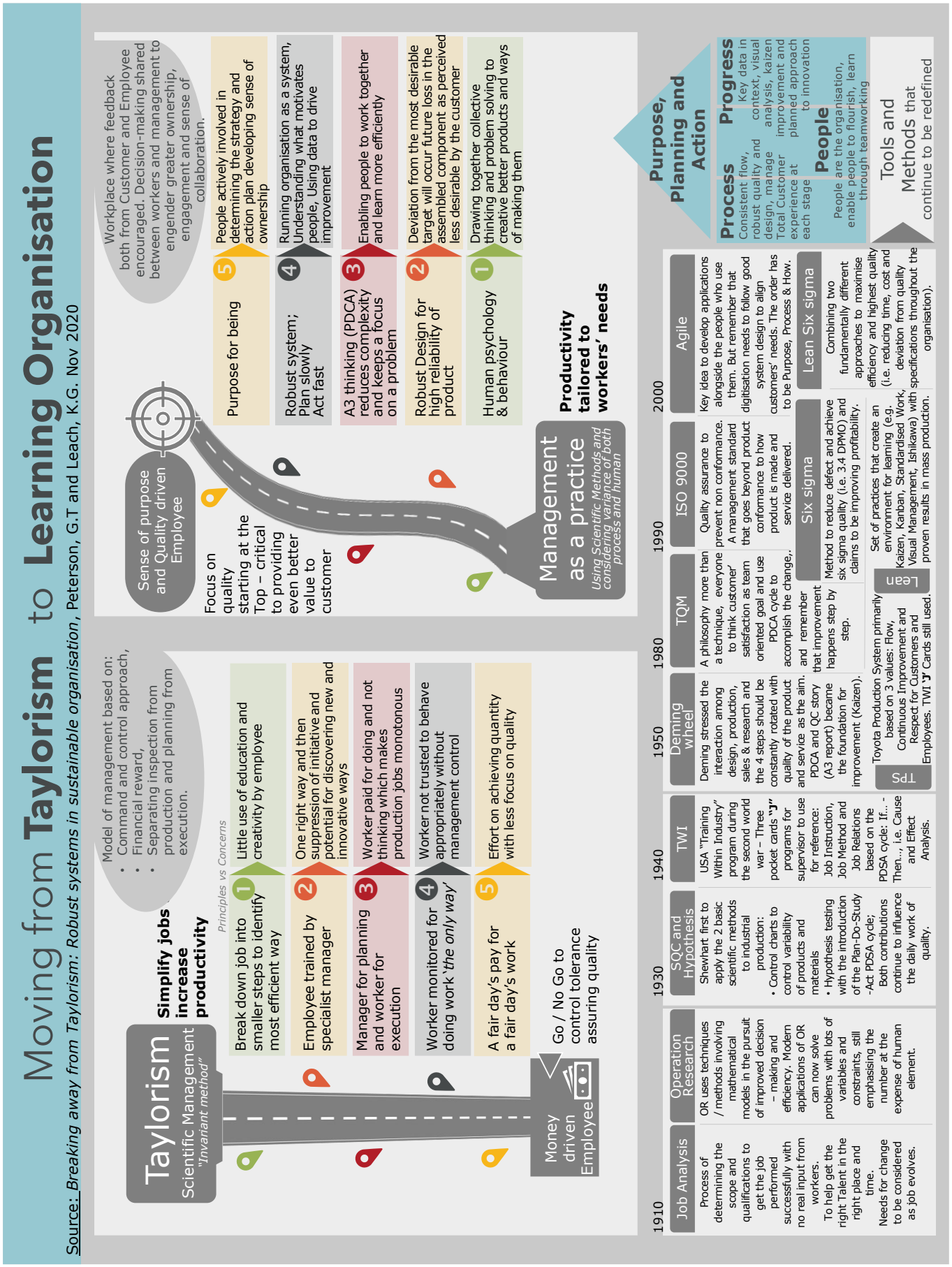
With a core focus on the Customer and Quality, such organisations deliver higher quality products and service, have fewer issues with their offerings in the field, have lower unit operating costs, work closely, collaboratively, and in harmony with their suppliers. Engage all the people within the organisation in training and learning so they can effectively engage in working on the day-to-day problems that confront any organisation in the course of its endeavours.

People in a learning organisation contribute to the learning and the adding to the organisation's body of knowledge in building the robustness of the organisation. These collective activities future proof the dissemination of knowledge from those retiring as their knowledge has already percolated through the organisation, by the very nature of how the organisation operates.

Knowledge is only power when it is disseminated and put to work for the benefit of the organisation, it's people, and most importantly, its customers.

On the following page is a visual summary of the paper prepared by: Angélique Macrez, one of the peer reviewers of this paper. The summary shows the development of management thinking from 1910 to the present day. It also shows the interconnectivity of systems and the benefits of changing to an Adaptive and Learning Organisation. The authors are indebted to Angélique Macrez for her learning contribution. See also Appendix 6 where the graphic is repeated at a larger scale.

Angélique is Head of Performance Improvement for the Osborne Group, reporting directly to the CEO. She has 20-year experience in quality professional roles, mainly in the construction industry. She advocates a '*Gemba Walks'* approach to driving quality improvement across business. In this way people at all levels work closely and collaboratively to improve processes, create novel visual solutions and ultimately shift mindsets on how people engage with quality approaches. She was the winner of the CQI Quality Professional of the Year Award in 2019.



ABSTRACT

At the start of the twentieth century, Fredrick Winslow Taylor formulated his model of 'Scientific Management', based on a study of working practices and in which he sought a 'one best way' to perform each task. His ideas caught the imagination of industrialists and a first formal structure for the management of an organisation was born.

His Scientific Management wasn't adopted universally, but its elements can still be seen everywhere. The problems associated with Tayloresque theories and practice are explored, along with their derivatives of Six Sigma, Lean Six Sigma and Agile. Examples of its pervasive influence are the widespread attempts to measure human performance and to place emphasis on incentives; separating the management from action; with a requirement for standardised output within a project driven framework which focuses on cost.

We attempt to answer the question "is there is a science of management?" Management uses science / technology to simplify the administration work, improve it and fulfil the needs of people and the organisation. As such, management is a practice. That *"Management is a necessary function in an organisation, not a status";* is an often-quoted line, generally attributed to Myron Tribus. (i)

We examine the great strides made in the early 1940s in America with the development of the TWI (Training Within Industry) programmes which laid the foundations for sustainable and adaptive management practice, training for employees and mutual cooperation between business and workers.

Later, Deming and others in Japan - developed a management practice that built on the foundations of Shewhart and others and which became established in Japan and elsewhere, but which, given its roots, has ironically proven difficult to embed into western organisations.

From these we will propose the elements a modern adaptive and learning management practice that takes us beyond the problems associated with scientific management, it's derivatives, and subsequent thinking.

Simply, you need to be sustainable now in order to secure the future.

(i) Myron T. Tribus (October 30, 1921 – August 31, 2016) was an American organizational theorist, who was the director of the Center for Advanced Engineering Study at MIT from 1974 to 1986. *This citation source Wikipedia*.

INTRODUCTION

Why should we break from Taylorism / Scientific Management?

Since its publication, F W Taylor's '*Principles of Scientific Management'* in 1911, [1] his ideas have provided the fundamental thinking behind management practice, despite its obvious drawbacks.

In this paper we look at the detail of Taylorism and outline a number of concerns about so-called Scientific Management and its descendants. This leads us to believe that a break from Taylorism is required and a change to a modern adaptive and learning management approach is needed.

We focus on two historic strands in management practice in this and later periods. The first strand in management thinking starts with Taylorism and runs through Job Analysis, Operations Research to Six Sigma and Lean Six Sigma today. We show that there are common methodologies in all of these.

The second strand starts with Shewhart and SQC (ii); and runs through TWI (ii) and TQC (ii) / Lean Production to current best practice.

This paper consists of two main parts. The natural inflection point that separates these two strands occurs at the end of World War II.

In ***PART ONE*** we present an outline of Taylorism / Scientific Management and other related elements of management thinking.

What are the elements of the "scientific method" that Taylor uses as the basis of his scientific management? Are these valid?

The problems associated with Tayloresque theories and practice are explored. Despite this, why forms of Taylorism continue to be used and persist?

There follows a brief outline of scientific methods that are pertinent to this discussion, and whether there is a science of management at all.

Meanwhile in 1924 Shewhart's pioneering work used the well-known scientific methods of interoperability of observations/data, and the well-established concept of hypothesis testing.

The major effort to build US production and quality in World War II, was under the banner of Training for Work in Industry (TWI).

(ii) SQC Statistical Quality Control; TWI Training Within Industry; TQC Total Quality Company.

In ***PART TWO*** we look at developments after the end of World War II, by drawing on both strands of this paper. Firstly, programmes that include the application of elements of scientific methods management of an organisation. Second, later progammes that are essentially based on Taylorism, such as Six Sigma, Lean Six Sigma (iii) and Agile.

We start with the exploratory visits by Japanese managers in the early Twentieth Century, seeking to improve methods of production.

At the end of the war, there was more demand than capacity in post-war America, and TWI was seen as having done its job, and was no longer necessary.

In the Far East, General Douglas MacArthur understood that if efforts were not made to re-build the industrial infrastructure of Japan, it was highly likely that it would descend into chaos with the attendant issues for the occupying powers. The fundamental decision was to bring the expertise in manufacturing from the USA to Japan.

Chosen for this task were (amongst others) Deming and Juran, who taught the Japanese their statistical methods and associated management theories. These grew into the success stories that have abounded for decades about Japanese manufacturing prowess. The rebuilding of the Japanese economy led to significant progress in TQC. Given the spectacular success in Japan with CWQ, (iv) it is disappointing that TQM achieved only moderate success in the West (v). We look at reasons for the lack of conspicuous success of TQM, which led to the attraction of management fads such as Six Sigma and Lean Six Sigma which proved unsuccessful.

Finally, we develop an approach to the structure and conduct of an organisation, founded on adaptive approaches and sustainable methods. We propose the elements a modern adaptive and learning management practice that takes us beyond the problems associated with scientific management and subsequent thinking.

(iii) not to be confused with Lean alone which is based on the scientific principles developed by Shewhart and later Deming and Juran, but integrated and honed by the Japanese.

(iv) CWQ – Company Wide Quality. See also 2.2.1 and 2.2.2.

(v) Putting the Organisation before People is shown to lead to many of the corporate ills we see today.

PART ONE

THE ORIGINS AND GROWTH OF TAYLORISIM

AND ITS ATTENDENT PROBLEMS

1.1 HISTORICAL CONTEXT

How did the necessity for forms of management arise, and how did it change to meet the needs of large organisations and mass-produced product?

Prior to the nineteenth century there was little in the way of a Theory of Management

There has been a contingent of development ideas over two millennia or more, as ideas developed pragmatically over time, with no consistent long-term methodology, grounding, or philosophical principles.

Organisations copied from the observed best arrangements developed over time in religious hierarchies, military forces and the administration of empires and these have been imported pragmatically.

This historical process is described by Oliver Wendell Holmes [2]; *'The customs, beliefs or needs of primitive time establish a rule or formula. In the course of centuries, the custom, belief, or necessity disappears, but the rule remains. The reason which gave rise to the rule has been forgotten, and ingenious minds set themselves to inquire how it is to be accounted for.*

Some ground of policy is thought of, which seems to explain it and to reconcile it with the present state of things; and then the rule adapts itself to the new reasons which have been found for it, and enters upon a new career. The old form receives a new content, and in time even the form modifies itself to fit the meaning which it has received', (2011 [1881], pp8).

But, following Holmes, there is little evidence of a fundamental philosophical grounding, rather libertarian justifications are *ex post facto*, loosely based on the concept of self-ownership, which justifies private property.

The industrial revolution brought about a complete change in the methods of production, tools and equipment, organisation of labour and methods of raising capital.

Employees went to their work instead of receiving it, and so, the factory system, as it is known today, became a dominant feature of the economy. These changes, in turn, brought about changes in the field of management.

Adam Smith (1723-1790). In his book, *The Wealth of Nations (1776)* [3] believed labour was paramount, and that a *division of labour* would effect a great increase in production. One example he used was the making of pins. One worker could probably make only twenty pins per day. But if ten people divided up the eighteen steps required to make a pin; they could make a combined amount of 48,000 pins in one day. However, Smith also concluded that excessive division of labour would negatively affect a worker's intellect through the carrying out of monotonous and repetitive tasks and hence he called for the establishment of a public education system. (i)

(i) This may feel a little incongruous: if, as described by Smith, poorly educated people are described as being easily bored by repetitive work, then more highly educated people will be the more so. But it reflected the social structure of the time.

Robert Owen (1771-1858) [4] is considered as a pioneer in the field of human resource management process. He advocated the necessity of concern for the welfare of workers.

Charles Babbage (1792-1871) [5] advocated the use of accurate observations, measurement and precise knowledge for taking business decisions. He also advocated the ideas of specialisation of mental work and emphasised the necessity of profit sharing.

Waring [6-pp4] notes "[internationally]…*the rise of the modern managerial enterprise in the last half of the 1800s had been an economic phenomenon and not a political one that stemmed from the power of technology and the imperatives of market forces. Not the power of business professionals to dominate government and labour or the imperatives of culture."*

And this is exemplified through the development of steam power and the growth of railways. In Great Britain, the railway boom of the 1840s expanded local networks into a national network with attendant needs such as standardised time. Whilst in the USA the railway boom of the 1850s followed the model of Great Britain. Expansions of infrastructure and changes in technologies exposed the need for the railway companies to find ways to *"manage"* the assets and operations on both a local and wider geographical basis.

As General Superintendent of the New York and Erie Railroad, McCallum developed new ideas about a modern system of management. In his 1856 report he formulated the following requirements:

"*A system of operations to be efficient and successful should be such as to give to the principal and responsible head of the running department a complete daily history of details in all their minutiae. Without such supervision, the procurement of a satisfactory annual statement must be regarded as extremely problematic. The fact that dividends are made without such control does not disprove the position, as in many cases the extraordinarily remunerative nature of an enterprise may ensure satisfactory returns under the most loose and inefficient management..."*

McCallum presented the following general principles for the formation of such an efficient system of operations;

- First. A proper division of responsibilities.
- Second. Sufficient power conferred to enable the same to be fully carried out, that such responsibilities may be real in their character.
- Third. The means of knowing whether such responsibilities are faithfully executed.
- Fourth. Great promptness in the report of all derelictions of duty, that evils may at once be corrected.
- Fifth. Such information to be obtained through a system of daily reports and checks that will not embarrass principal officers nor lessen their influence with their subordinates.
- Sixth. The adoption of a system, as a whole, which will not only enable the general superintendent to detect errors immediately, but will also point out the delinquent.

About the core principle of management, he summarized; "*All that is required to render the efforts of railroad companies in every respect equal to that of individuals, is a rigid system of personal accountability through every grade of service...*"

Vose (1857, p. 416) [7] added, that all subordinates should be accountable to, and directed by, their immediate superiors only. Each officer must have authority, with the approval of the general superintendent, to appoint all persons for whose acts he is held responsible, and to dismiss any subordinate when in his judgment the interests of the company demand it.

Andrew Ure (1778-1857) [8] and Charles Duplin (1784-1873) [9] emphasised the necessity of management education, which paved the way for professionals manning the management positions.

Henry Robinson Towne (1844-1924) [10] urged the combination of engineers and economists as industrial managers.

On reviewing the contributions of pre-classical theorists, it is clear that their emphasis was more on developing some specific techniques to solve some identified problems. Because of their obvious technical background, they did not think of management as a separate field.

By and large, they integrated management with their respective areas of specialisation. It was Andrew Ure, Charles Duplin, and Henry Robinson Towne who laid the foundations of the management theories that ultimately shaped the management thoughts we see today.

Classical theory, was closely associated with the industrial revolution and the rise of large-scale enterprise.

Early management structures were ostensibly bureaucratic in nature (gleaned from the Military and/or Government); separating ownership from control, sub-dividing central management roles into defined groups for ease of control. This is, limiting the parts of the operation any single salaried manager had to cover. Whilst work-load was controlled, segregation morphed into silo style operations, with the attendant issues seen in current organisations. But what this inadvertently did was to create competition between the silos which made managing the whole more complex, and to a large extent, illusionary (or practically impossible).

Classical organisation and management theory were based on contributions from a number of sources. They are scientific management, administrative management theory, bureaucratic model, micro-economics and public administration.

Management thought focused on job content, division of labour, standardisation, simplification, specialisation and scientific approach towards organisation.

We can identify two strands in Classical Theory;

BUREAUCRATIC MODEL

First used by Weber [11] in his model of bureaucracy, 1905, it included:

- Hierarchy of authority.
- Division of labour based upon functional specialisation.
- A system of rules.
- Impersonality of interpersonal relationships.
- A system of work procedures.
- Placement of employees based upon technical competence.
- Legal authority and power.

A Bureaucratic Model is preferred where change in the organisation is not anticipated or where the rate of change can be predicated. It is followed in government departments and in large business organisations.

ADMINISTRATIVE MANAGEMENT

Henry Fayol [12] developed a theory of general and industrial management; but Taylor had the greatest influence on later management thinking. In *Principles of Management 1916*, Fayol divided general and industrial management into six groups:

- Technical activities - production, manufacture, adaptation.
- Commercial activities - buying, selling and exchange.
- Financial activities - search for and optimum use of capital.
- Security activities - protection of property and persons.
- Accounting activities - stock-taking, balance sheet, cost, and statistics.
- Managerial activities - planning, organisation, command, co- ordination and control.

These six functions had to be performed to operate successfully any kind of business. He, however, pointed out that the last function i.e., ability to manage, was the most important for upper levels of managers. The process of management as an ongoing managerial cycle involving planning, organising, directing, co-ordination, and controlling, is actually based on the analysis of general management by Fayol. Hence, it could be said that Fayol established the pattern of management thought and practice. Even today, management process has general recognition.

1.2 TAYLORISM / SCIENTIFIC MANAGEMENT

As the United States' industrial economy grew in the late 1800s, conflict between workers and factory owners became increasingly frequent, leading to strikes and sometimes violence.

For example, the strike at the Carnegie Steel Company's Homestead Steel Works in 1892 culminated in a gun battle between unionised steelworkers and a group of men hired by the company to break the strike. The steelworkers ultimately lost the strike.

Having worked extensively in the steel working business, Taylor put forward the proposal that scientific management could be used to reduce these conflicts, and to secure the maximum prosperity for the employer, coupled with the maximum prosperity for each employee.

In the same way maximum prosperity for each employee means not only higher wages than are usually received by men of his class, but, of more importance still, it also means the development of each man to his state of maximum efficiency, so that he may be able to do, generally speaking, the highest grade of work for which his natural abilities fit him, and it further means giving him, when possible, this class of work to do. The majority on both sides believed that the fundamental interests of employees and employers were necessarily antagonistic

His concept of scientific management, on the contrary, has for its very foundation the firm conviction that *the true interests of the two are one and the same; that prosperity for the employer cannot exist through a long term of years unless it is accompanied by prosperity for the employee, and vice versa; and that it is possible to give the workman what he most wants high wages and the employer what he wants a low labour cost--for his manufactures*.
No one can be found who will deny that in the case of any single individual the greatest prosperity can exist only when that individual has reached his highest state of efficiency; that is, when he is turning out his largest daily output.

In the early part of the twentieth century, F. W. Taylor started the Scientific Management movement, and later, joined by Frank and Lillian Gilbreth and Henry Gantt, they studied the work process scientifically. They studied how work was performed, and they looked at how this affected worker productivity. Taylor's philosophy focused on optimising the way the work was done, so the worker could work at an acceptable rate for longer, rather than working as hard as possible for as long as possible.

Taylor started work at the machine-shop of the Midvale Steel Company in 1878, after having served an apprenticeship as a pattern-maker and as a machinist, he became gang-boss of the lathe shop. Midvale workers were paid by the piece, a system known as piece-rate. Despite many efforts he could not cajole the operatives into working harder. He started a series of experiments on cutting tools, where he established the most efficient way of cutting metal. He standardised machining, while indifferent to the inadvertent consequence of psychological damage to workers moral.

In 1899, he finally found his ideal workman. Bethlehem Steel Works had a surplus of pig iron and Taylor as consultant was given the task of finding the best way to shift this surplus. The back breaking work consisted of loading each 45 kg bar of iron (known as a 'pig') onto a railway car. He discovered one man capable of

shifting the required number of pigs (47.5 tons) over a shift and used this as the norm. One man after another was picked out and trained to handle pig iron at this rate until all of the pig iron was handled at this rate, and the men were receiving 60 per cent more wages than other workmen around them. Hard work was traded off for better wages.

Taylor started his own business in 1910, promoting his management and machining methods. In the Eastern Rate Case [13], the company's attorney recommended Taylor's "S*cientific Management*" as the new management system for the Eastern Railroad to adopt. Taylor was asked to testify but refused; eventually he was persuaded to testify once the attorney's claim gained public awareness. With a wider audience, his Scientific Management methodologies became famous worldwide. He was encouraged to write a paper for ASME (ii) encapsulating the *Principles of Scientific Management*, this was published by Harper in 1911. In this, he proposed that by optimising and simplifying jobs, productivity would increase. Taylor's book was profoundly influenced by the concerns of the science—particularly the physics—of his time. Newtonian physics and thermodynamics allowed scientists to calculate how machines could function with maximum efficiency.

From the Introduction to his book, Taylor was preoccupied with the problem of efficiency as it applies to organisations. When it comes to natural resources, he argued, people clearly understand the need for efficiency because *"we can see and feel the waste of material things." But our larger wastes of human effort, which go on every day through such of our acts as are blundering, ill-directed; or inefficient, and which Mr. Roosevelt refers to as a lack of "national efficiency," are less visible, less tangible, and are but vaguely appreciated.* According to Taylor, the fundamental cause of this waste of human effort was unscientific management.

He rejected the traditional craftsmanship by which workmen in each trade had been taught the details of their work by observation of those immediately around them, resulting in many different ways in common use for doing the same thing, and for the same reason there is a great variety in the implements used for each class of work.

The underlying philosophy of such systems of management meant that each workman was left with the final responsibility for doing his job practically as he thinks best, with comparatively little help and advice from the management. Making it impossible for the men working under these systems to do their work in accordance with the rules and laws of a science or art, even where one exists.

A factory manager at that time would have had very little contact with the workers, leaving them on their own to produce the necessary product. (in a sense, a legacy of the class system in which managers/supervisors represented owners). There was no standardisation, and a worker's main motivation was often continued employment, so there was no incentive to work as quickly or as efficiently as possible.

He assumed there is always one method and one implement which is quicker and better than any of the rest. And that this could be discovered by a scientific study and analysis of all of the methods and implements in use, together with accurate, minute, motion and time study. This involves the gradual substitution of science for rule of thumb throughout the mechanic arts.

(ii) American Society of Mechanical Engineers

The Scientific Management theory focused on improving the efficiency of each individual in the organisation. The major emphasis was on increasing production through the use of intensive technology, and in doing so, human beings were just considered as adjuncts to machines in the performance of routine tasks.

He studied the optimal way to do any type of workplace task. As such, he found that by calculating the time needed for the various elements of a task, he could develop the "*best*" way to complete that task. These "*time and motion*" studies also led Taylor to conclude that certain people could work more efficiently than others. These were the people whom managers should seek to hire where possible. Therefore, selecting the right people for the job was another important part of workplace efficiency.

Neither of these approaches addresses quality as a direct and necessary attribute of the produced item. Two points arise:

a) by breaking down tasks into smaller and smaller steps, or packages, it could be assumed (erroneously as we know today) that all the items produced would be 'properly and correctly' made.

b) it is likely that such as tolerances of fit, would be sufficient with GO – NOGO gauging. But this still leaves errors that impact the quality of finished product. (iii)

Friedman [14] says that Taylor's principles inaugurated a revolution in management and in the organisation of work. In the decades after his book's publication, his ideas contributed to massive increases in productivity and the economic standard of living of the workers.

He proposed a set of new duties for managers, grouped under four headings: (iv)

First. They develop a science for each element of a man's work, which replaces the old rule-of-thumb method. Gathering together all of the traditional knowledge which in the past has been possessed by the workmen and then of classifying, tabulating, and reducing this knowledge to rules, laws, and formulæ which are immensely helpful to the workmen in doing their daily work.

Second. They scientifically select and then train, teach, and develop the workman, whereas in the past he chose his own work and trained himself as best he could.

Third. They heartily cooperate with the men so as to insure all of the work being done in accordance with the principles of the science which has been developed.

Fourth. There is an almost equal division of the work and the responsibility between the management and the workmen. The management take over all work for which they are better fitted than the workmen, while in the past almost all of the work and the greater part of the responsibility were thrown upon the men.

(iii) see Taguchi's Loss Function described in *The Deming Dimension* by Neave H. also Appendix 3

(iv) in the original English

1.2.1 ELEMENTS OF TAYLORISM

Taking what he learned from these workplace experiments, Taylor developed the "*principles of scientific management"*;

1. Science, not rules of thumb.

Rather than doing things how they've always been done, Taylor wanted each job to be studied scientifically to identify the most efficient way to do that job. Taylor advocated using time and motion studies as the way to do this. This often involved looking at the most efficient workers to identify why they were so efficient. The ultimate aim was to describe in a repeatable way how to do the job in the most efficient manner.

2. Scientifically train employees.

He considered the work performed on the production floor (and ancillary places), as separate and profoundly different from that performed in other parts the organisation. The work there consists mainly of repetitive tasks, with the individual workers' daily activities being divided into a large number of cyclical repetitions of same or closely related activities. Activities of this nature did not allow the individual worker scope to exercise complex-problem solving activity. Therefore, more attention was focused on the standardisation of working methods.

He didn't want employees thinking for themselves, he simply wanted a simple task performed as quickly (efficiently) as possible. In a nutshell, workers should be paid for doing, not thinking. (v) So, everyone in the organisation can be trained to do a job in a standard way. To help with this, managers should break down each employee's job into more manageable, bite-sized tasks, and teach them exactly how each task should be performed by a specialist manager

He believed that workers need not be expensively trained. Consequently, no pride in their work was required on behalf of the worker either.

3. Ensure most efficient ways of working are used.

The aim of this step is to maximize production, unlike in situations where 'soldiering' occurs. That is situations where workers naturally slack off because they are not being monitored. He attempted to find the most efficient way of performing any job. He believed that there were universal laws which governed efficiency and that these laws were independent of human judgment. The goal was to find this *"one best way"* of doing things as efficiently as possible. There are three parts to ensuring that the most efficient ways of working are being used:

- Monitor worker production to ensure that they are efficient.
- Work with employees to retrain and recalibrate them, so that they are exactly following the most efficient way to perform their job.
- Develop tools such that a worker can work harder for longer. (vi)

(v) As we shall see later, a common theme in the Taylor style of management, and as still practiced is: "don't sit there thinking, do something". But the most successful, learning and adaptive organisations employ a process of slow deliberation followed by rapid deployment.

(vi) Taylor's experiments on shovel design at Bethlehem steel Work

One consequence of this was that organisational structures had to change. Rather than a factory having one single foreman, Taylor advocated several, each one specifically focused on efficiency for a particular area of the factory.

He also studied the design of tools (shovels) to maximise the length of time a man could keep working.

4. Divide work between managers and workers.

Work should be divided between managers and employees.

- Managers should be responsible for developing the processes, ways of working and monitoring employees.
- Employees should be responsible for executing a task as quickly as possible.

5. Pay based on results.

Taylor attempted to bring a scientific approach to production, with little regard for the human needs of workers. He believed that all workers were motivated by money, and their perceived standing in society alone, so he promoted the idea of "*a fair day's pay for a fair day's work*." In other words, if a worker did not achieve enough in a day, he didn't deserve to be paid as much as another worker who was more highly productive. In his scheme, he did not ask for initiative from his men. All he wanted of them was to obey the orders they were given, do what was said, and do it quickly.

Taylor believed that all workers were solely motivated by money, so he promoted the idea of "*a fair day's pay for a fair day's work*." The origin of *Piece Work*. The use of piece-rate pay focuses workers minds on their productivity. If they don't produce, then they don't earn. This was thought to create a win-win situation. Workers are incentivised to work hard to earn more and as such the business's production will be as efficient as it can be (profits are maximised).

1.2.2 CONCERNS ABOUT TAYLORISM

Despite the near ubiquitous range of adoption of Tayloresque ideas, there are major problems as a result.

Can you Maximize the efficiency of human effort?
This is a well-known fallacy; that has existed from classical times through to the present. The claim is: 'If you maximize the efficiency of the individual, you maximize the efficiency of the organisation'. However, Deming [15] states that individual performance cannot be measured except possibly in the long term, the performance of the individual is mainly governed by the process in which they work. And control of the process was in the hands of managers.

Workers are human beings and cannot be standardised in the same way as machines and materials. Any attempt to standardise their activities will have limited success. Each human being has their own abilities, style and ways of doing things.

There is growing resistance of employees, especially young employees, to spend years of their lives doing work which poses little challenge, which makes little use of their education or their creativity. The system is also under attack from the outside, as we discover that there are entire industries in which we are outperformed by others in countries which operate under different systems.

Incentive pay destroys the system
The effect of incentive pay is to focus the individual's effort on achieving the numbers, with the consequent loss of focus on the aim and quality.

Taylor's view of the motivations of workers has had a profound influence throughout the century until the present day. His belief that man was rational and would make economic choices based on the degree of monetary reward, led him to devise payment systems that closely related the kind of effort he sought with the level of reward offered. Not surprisingly, there was strong criticism of this theory that treats human beings like machines and assumes that workers are satisfied by money alone.

Payment of wages on piece work basis only works in the short term. Locke [16] found that when subjects were paid on a piece-work basis (vii) they tended to choose easier tasks as the of level payment increased. A number of other studies have also found that people working for a reward generally try to minimize challenge. It isn't that human beings are naturally lazy or that it is unwise to give employees a voice in determining the standards to be used.

Rather, people tend to lower their sights when they are encouraged to think about what they are going to get for their efforts. "*Do this and you'll get that*," in other words, focuses attention on the "*that*" instead of the "*this*."

Contrary to conventional wisdom, the use of rewards does not result in workers focussing on the job, rather, incentives help create a focus on financial considerations. Emphasising large bonuses is the last strategy we should use if we care about innovation. Do rewards motivate people? Absolutely. They motivate people to get rewards. See Kohn [17].

(vii) see also sect. 1.4 and Appendix 2 on Motivation.

Among the few workers who qualified as "*first-class*" in Taylor's studies, Schmidt was used as a vindication of his methods. But he was an anomaly; of 40 men hired in the course of a few months, managers determined that only three were "*first-class*."

Ultimately, the piece rate system was successful in reducing costs for management and raising pay for the best workers, but there was little that was particularly "*scientific*" about the process.

"*If it proved anything, it was the persistence of haphazard, unsystematic methods, even among the leaders of the management movement*". Nelson [18] writes. *The managers only got a significant number of recruits for the new payment system after they started treating workers in "a liberal way" and providing alternative duties when they were tired or hurt*.

One of the dangers to be guarded against, when the pay of the man or woman is made in any way to depend on the quantity of the work done, is that in the effort to increase the quantity, the quality is apt to deteriorate. Workers do not usually enjoy work (viii). Because of this, they need to be monitored and controlled closely. Essentially, Taylor believed that employees had a natural tendency to take it easy or slack off whenever they could. He called this *'natural soldiering'*

Managers who insist that the job won't get done right without rewards have failed to offer a convincing argument for behavioural manipulation. Promising a reward to someone who appears unmotivated is a bit like offering salt water to someone who is thirsty. Bribes in the workplace simply can't and don't work. See Kohn.

Separation of Management from Workers

Quoting Drucker [19], *"…this reflects a dubious and dangerous philosophical concept; that an elite has a monopoly on knowledge, entitling it to manipulate the unwashed peasantry! Planning and doing are separate parts of the same job, not separate jobs. Productivity and effectiveness are greatly increased when workers are given responsibility for planning their work."*

The manager's task is therefore to use hierarchical authority to prevent the opportunists from benefiting at the cost of others. To ensure effective coordination, managers must know what everyone ought to be doing, give them strict instructions to do those things, and use their ability to monitor and control and to reward and punish to ensure that everyone does what he or she is told to do. This is the exercise of "fiat."

What is the outcome of such a management approach? It is likely to be, and there is significant evidence that it indeed is, exactly the opposite of what Williamson's [20] theory predicts: Instead of controlling and reducing opportunistic behaviour of people, it is likely to actually create and enhance such behaviours (Ghoshal & Moran, 1996) [21].

For managers, the net consequence of adopting Williamson's advice is what Strickland (1958) [22] has described as "*the dilemma of the supervisor*": The situation when the use of surveillance, monitoring, and authority leads to management's distrust of employees and perception of an increased need for more surveillance and control. Because all behaviour is seen by managers as motivated by the controls in place, they develop a jaundiced view of their people.

(viii) this is in direct contrast to what is found in studies about motivating people. See Appendix 2

For the employees, the use of hierarchical controls signals that they are neither trustworthy nor trusted to behave appropriately without such controls.

Surveillance that is perceived as controlling threatens peoples' personal sense of autonomy and decreases their intrinsic motivation. It damages their self-perception. One of the likely consequences of eroding attitudes is a shift from consummate and voluntary cooperation to perfunctory compliance.

Scientific management focuses on efficiency, so, workers lose skill level and autonomy. This is not beneficial for an effective work-place, it suppresses their initiative and the potential for discovering new and innovative ways. It restricts improvement.

According to Warring (1992, p.206), "*by centralising power with managers, separating planning from performance, and specialising tasks, firms were encouraging excessive bureaucracy. Managers did not visit the production floor and were thus ignorant of many production matters. They manipulated people like any other factor of production."*

Lack of focus in improvement.

Scientific Management was conceived to benefit both worker and company, but the reality is that it benefits the company far more than the worker. This has resulted in much industrial action and strikes in the last 110 years.

It is often seen as dehumanising. This is because workers are encouraged not to think for themselves, they simply have to follow a few simple instructions as quickly as possible. Although production is increased it creates very monotonous jobs containing no autonomy.

Again, quoting Deming; "*The obligation of the individual is to aim for improvement in the system, and thus to improve his own performance and that of everyone else in the system"*. Opponents of Taylorism advocate a plurality of methods for increasing productivity, which should be tailored to workers' needs. Feedback should be encouraged and decision-making shared between workers and management to engender a greater sense of participation and ownership, greater engagement, and a stronger sense of collaboration between workers and management.

However, the quest for efficiency and speed could be seen as detrimental to quality. As a result, organisations introduced separate quality inspection departments charged with assuring quality defined by tolerances measured using GO / NOGO gauges. In Taylor's piece part system, only items within tolerance counted for incentive payments.

In one cited example he says; *"It is necessary in almost all cases, therefore, to take definite steps to insure against any falling off in quality before moving in any way towards an increase in quantity. In the work of these particular girls, quality was the very essence."* They were engaged in picking out all defective balls [14]. Taylor may have inspected for tolerance, but at that time, there was not an awareness of the need to achieve quality before quantity.

One right way
Scientific Management attempts to firmly establish the one best way of doing a task, without considering the variation in performance of the individual workers. Even though this is flawed, it is still found in one form or another in many organisations today.

Analysis is not the same as synthesis
Again, quoting Drucker, he writes: "*…that the belief that work is best performed as it is analysed is wretched engineering*". The confusion between analysis of work and action in work is a mistake of the Human Resource people that purport to organise human work. It is based on the unfounded assertion that the human being is a machine.

Focus on standardised output rather than flexible process.
In the case of a machine-shop which is managed under the modern system, detailed written instructions as to the best way of doing each piece of work are prepared in advance, by people in the planning department. These instructions represent the combined work of several men in the planning room, each of whom has their own specialty, or function. The direction of all of these people, however, are written on a single instruction card, or sheet. A flaw in this approach is that an improved technique, or having to deal with upstream quality issues does not flow naturally back from those performing the work to those designing the work.

Service sector

In general, these conditions do not hold in the service sector. Furthermore, the quantities and the types of resources differ greatly from manufacturing industries. Within the service sector there is often more labour and less capital. This 'human emphasis' greatly limits the application of scientific management principles.

Targett (1995) [23] has identified seven distinctive characteristics that highlight the limitations of applying scientific management principles and therefore raising doubts over the 'inevitability' of such management practices being used in the service sector.

- Measurement of output and performance is difficult
- The 'product' is not tangible
- Production and consumption are usually simultaneous
- The 'product' is time perishable
- Site selection is governed by customers demand
- The industry is labour-intensive

In addition, people tend to be more unpredictable than machines and are therefore harder to encapsulate in a rationalization model.

As a general conclusion, there have been, and still are, many critics of Taylor and his ideas. Yet Taylor believed that employees and management should work as one for the good of the business. But, his methods benefitted the business more by making employees more efficient (ix).

Waring [4] writes, *"Workers objected to the way Taylorism and bureaucracy accelerated the pace of work, restricted autonomy, destroyed craft skills and hierarchies, lowered product quality and standards of workmanship, reduced workers from people to machines, undermined status and identity in the community, and caused wages to lag behind productivity and profits."*

Further, by assuming that the worker was driven by monetary reward alone, Taylorism only could work if job planning was separated from job doing, and that the work was further separated into smaller and smaller packages. This differentiation and diminution of skills would fundamentally disenfranchise workers who were by management, assumed to have no pride in their output.

Under the then economic and educational standards endured by the general pool of available labour at the time of Taylor, singular pursuit of financial reward and command job instruction could be considered as adequate models on which to base a theory, and subsequent practice, of a model for management.

But as the general workforce started to have more free time, be entitled to holiday periods and enjoy having some surplus money, the people started to seek other stimuli other than reward for their labour. Add to this mix the struggle for political recognition and voice, the general workforce started to be motivated by other than financial reward. They saw that they had some (albeit limited at the time) control over what they could do, and started to be motivated by drivers other than survival.

This in turn would change the way work would be perceived and the effort workers were prepared to expend on activities with closer affinity to their beliefs.

(ix) Being Efficient is not the same as being Effective. It is more important to be effective in ones labours than efficient. Afterall, you can be 100% efficient at doing completely the wrong thing, both damaging service to customers and the business itself.

1.2.3 IS TAYLORISM SCIENTIFIC?

In the Principles of Scientific Management, Taylor makes reference to "*the scientific method*", and makes the inference that Scientific Management is management carried out using the scientific method.

However, he does not make any attempt at a formal definition of the scientific method, nor how he has applied any of the elements of the scientific method. We can infer some of the elements of what he had in mind through close examination of his text.

He writes; "*the best way to do a task can only be discovered or developed through a scientific study and analysis of all of the methods and implements in use, together with accurate, minute, motion and time study. This involves the gradual replacement of rule of thumb by science throughout the mechanic arts*".

He proposes a formal division of work between management and workers; "*to work according to scientific laws, the management must take over and perform much of the work which is now left to the men; almost every act of the workman should be preceded by one or more preparatory acts of the management which enable him to do his work better and quicker than he otherwise could*".

From the above, it is difficult to see what, if any, element of scientific methods Taylor has applied to management.

A closer examination of "The Principles of Scientific Management" makes it clear that what Taylor has done is apply a very limited number of the elements of science/technology to the task of management. He says he wants to develop a Science of Management which discovers patterns and laws, like those found in professions such as medicine (x).

"the science of handling pig iron (xi) is so great and amounts to so much that it is impossible for the man who is best suited to this type of work to understand the principles of this science, or even to work in accordance with these principles without the aid of a man better educated than he is…" This is announced as a general principle. ***A general flaw here is that it assumes that managers do know best even if they are not experienced in the work of the worker***.

Measurement of time, distance and weight require little more than a stop-watch, a ruler and a scale. This does represent a substitution of simple science for the previous rule of thumb. However, it does not represent the leap forward he claims.

"Thus, all of the planning which under the old system was done by the workman, as a result of his personal experience, must of necessity under the new system be done by the management in accordance with the laws of the science; because even if the workman was well suited to the development and use of scientific data, it would be physically impossible for him to work at his machine and at a desk at the same time."

(x) Taylor was a Past President of the American Institution of Mechanical Engineers, and would have been greatly influenced by technological advances based on the development of Thermodynamics, Fluid Mechanics and Electricity with their commensurate physics and mathematical bases; in which sciences, certain laws are immutable.

(xi) Pig iron would have been tested for chemical composition, Fe, C, Si etc. which would have been beyond the ability of Taylor's workers to influence. But slag inclusions would have been a function of the speed of working.

He rejected the traditional craftsmanship by which workmen in each trade had been taught the details of their work by observation of those immediately around them, resulting in many different ways in common use for doing the same thing, and for the same reason there is a great variety in the implements used for each class of work. But, he assumed there is always one method and one implement which is quicker and better than any of the rest. And that this could be discovered by a scientific study and analysis of all of the methods and implements in use, together with accurate, minute, motion and time study. This involves the gradual substitution of science for rule of thumb throughout the mechanic arts.

"It is also clear that in most cases one type of man is needed to plan ahead and an entirely different type to execute the work." The practical use of scientific data also calls for a room in which to keep the books, records, etc., and a desk for the planner to work at.

Despite the over-exaggeration, what this does not represent is the establishment of a science of management. It is the application of simple physics!

We would say that there is no "Science of Management". In Section 1.3 and APPENDIX 1 we consider this in further detail.

What we find is that practical managers use elements of scientific methods to good effect. As opposed to Taylor's over exaggerated claims for his scientific management method, we consider that two key elements of scientific methods; interoperability of data and hypothesis testing, have been used by very successful management since World War II.

1.2.4 THE ROLE OF QUALITY IN TAYLORISM

Prior to the extensive division of labour and mechanisation resulting from the Industrial Revolution, it was possible for workers to control the quality of their own products. The Industrial Revolution led to a system in which large groups of people performing a specialised type of work were grouped together under the supervision of a foreman who was appointed to control the quality of work manufactured.

At the time of the First World War, manufacturing processes typically became more complex with larger numbers of workers being supervised. This period saw the widespread introduction of mass production and piece work, which created problems as workmen could now earn more money by the production of extra products, which in turn occasionally led to poor quality workmanship being passed on to the assembly lines. Piece parts had to be produced in a timely fashion, and they had to meet quality requirements. To counter bad workmanship, full time inspectors were introduced to identify, quarantine and ideally correct product quality failures.

Juran [24] says that "*Scientific Management has profoundly influenced our management of the quality function. It provided a strong impulse in the movement to separate inspection from production, i.e., to use full-time inspectors for product inspection and process control rather than to rely on the workmen".* (xii)

The proliferation of Taylor's piece work systems was a strong influence in the decisions to create independent inspection departments to take over the command of inspectors. The evolution of quality specialists (quality control engineers, reliability engineers) was again an extension of the concept of separation of planning from execution.

To make these proposals effective, Taylor separated work planning from execution. Next, he created industrial engineers and other specialists to prepare work methods and standards of a day's work. He then limited the foremen and workmen to *"control",* i.e., to execute the plans and meet the standards. The system "*worked*" – it achieved spectacular improvements in productivity. And under Taylor's competent advocacy, the system was widely adopted by American industry, took firm root and remains as the principal base of managerial thinking. At the time, there was a logic to support this thinking.

(xii) Now, we find, through seeing the organisation as an interconnected system that quality cannot be inspected in; it has to be designed into the product and processes from the start.

1.3 SCIENTIFIC METHODS

Cowles [25] traces the scientific method to a later period than the Scientific Revolution—the late nineteenth and early twentieth centuries. This makes sense, since it coincides with a tectonic shift in intellectual geography: the splitting of the sciences and the humanities into two diverging continents.

Cowles shows that what began as a universal process embracing human thought and natural evolution became a prescriptive list of rules setting science apart from everything else.

However, Taylor implies, there is no, single scientific method. There are many methods used by scientists, in different fields of scientific endeavour. In this complex field, we can identify some common themes. (This is not intended to be a comprehensive description of these methods; rather an overview to aid this discussion).

1. Define a natural ***phenomenon*** to explain.
2. Collect information (***data***) about these phenomena by going where they occur and making observations.
3. After collecting a lot of data, look for patterns in the data. Attempt to explain these patterns by making a provisional explanation, called a **hypothesis**.
4. **Test the hypothesis** by collecting more data to see if the hypothesis continues to show the assumed pattern. If the data does not support the hypothesis, it must be changed, or rejected in favour of a better one.
5. If a refined hypothesis survives all attacks on it and is the best existing explanation for a particular phenomenon, it is then elevated to the status of a ***theory***.

We have, in separate panels (Panel 1 and Panel2), identified and detailed, two of these; the interoperability of observations/data, and the well-established concept of hypothesis testing.

Frederick Winslow Taylor provides Cowles a further example: in his manifesto for scientific management, Taylor promised great increases in output if companies were run according to the scientific method.

An important aspect with a belief of this nature is that it assumes that humans are totally deterministic in seeking only financial reward, when, above a certain level, it is not their main focus.

INTEROPERABILITY OF OBSERVATIONS/DATA

It is important to measure the right things in context, to ensure that the reliability of the data is understood and that the data is presented in the right way.

What to Measure

The right, broadly-based measures give better understanding, selecting the specific measures requires careful thought.
There must be a clear definition of the context in which data will be obtained. This means an understanding of:

- Why is the data being obtained?
- What is the variation within the data?
- To what accuracy and using which standards?

What reliance can you put on the data?

- What bias is there in the data?
- Is the bias linear?
- Is the data Repeatable & Reproducible?
- Is the data stable over time?

How to Measure

- How they are obtained - by what method?

When to Measure

The frequency of measurement depends on what is happening in the system that is being studied.

Where to Measure

Measure objects and events as directly as possible in the system. Avoid any chance of pre-filtering the raw data.

Who Measures?

When using existing data, it is important to know who carried out the measurement, and the reason for the measurement. What was their purpose and did it affect the way that they collected the data?

Panel 1: Interoperability of Observations / Data

HYPOTHESIS TESTING

1 Collect information (***data***)

About these phenomena by going where they occur and making observations.

2 Construct a Hypothesis

A hypothesis is an educated guess about how things work. It is an attempt to answer your question with an explanation that can be tested. A good hypothesis allows you to then make a prediction:
"**If _____,** *[I do this]* **_____, then _____*[this]*_____ will happen.**"

State both your hypothesis and the resulting prediction you will be testing.

Method of measuring predicted output must be defined.

3. Analyse Results and Draw a Conclusion

Collect measurements and analyse them to see if they support the hypothesis or not.

If the predictions are accurate, the hypothesis is supported, consider further tests of the hypothesis, in a different way, to achieve confirmation.

If the predictions were not accurate and the hypothesis was not supported; consider going back and constructing a new hypothesis, (and predictions), based on the information learned during the experiment.

Panel 2: Hypothesis Testing

A comparison of *Science v. Technology* is given in Panel 3.

SCIENCE VS. TECHNOLOGY

Definition of Science

Science is a system of obtaining knowledge, through experimentation and observation, so as to elucidate natural phenomena. It is a methodical and rational approach to exploration.

The knowledge is based on facts and evidence, relating to the subject, rather than opinions and personal choices. Research is continuously made, to expand our scientific knowledge, which leaves a room of question for further investigation.

Definition of Technology

Technology is a combination of technique, skills, processes, design, products, etc. which is dedicated to the practical application of science in industrial, commercial or everyday use. Most people use technology, to simplify their work and also to extend their abilities. It also ensures a solution to various scientific problems.

Key Differences Between Science and Technology

Science can be defined as an organised way of gathering knowledge on a subject, through various observations and experiments. Technology is the practical usage of the laws of science for different purposes.

Science is a process of exploring new knowledge, whereas technology is putting scientific knowledge into practice.

Science is concerned with analysis, deduction and theory development. On the other hand, technology is based on analysis and synthesis of design.

Science is used to make predictions whereas technology simplifies the work and fulfil the needs of people.

Conclusion

To sum up, we can say that science is knowing, but technology is about doing. When it is about solving of problems both the two disciplines work together. Science has helped us in gaining knowledge of the things existing in the universe and also to make predictions on future outcomes. Technology, on the other hand, has helped us in simplifying our work by providing us various products, that helps us to get better results in less time.

Panel 3: Science v. Technology

1.4 MOTIVATION

A further, and at the time largely irrelevant, difficulty with the Taylor method, was the absence of understanding of what really motivates people. It was assumed at the time of Taylor, that workers were solely motivated by money and their standing in society. And to some extent at a time of low education, low income and few readily available commodities this view would be largely relevant.

The difficulty arises once the pool of available labour becomes more healthy, better fed, better educated and where there are a broad range of tradeable commodities available.

When this occurs, the focus of the pool of labour changes. No more are they singularly motivated by financial reward, but become increasingly motivated by a desire for the freedom to think, to question, and in addition, they increasingly require reason for the tasks in which they are engaged. That is, they start to require more control over what they are paid to do. Indeed, they start to question what it is they are being asked to do, and why they are being asked to do it.

For more information, background and detail see Appendix 2

1.5 WHAT FOLLOWED SCIENTIFIC MANAGEMENT

The Principles of Scientific Management was printed in 1911. Over the following 100 years, theorists who followed Taylor added to his ideas and developed management concepts, such as:

Job analysis,

Operations research,

Six sigma, and

Lean six sigma,

In these we can still identify the basic elements of his philosophy:

- Separation of planning from operations,
- Expert lead Project management,
- Improvement of each job function / workers,
- Standardised output and
- Payment by Results (based on short term objectives)

There can be no doubt that the essence of Taylor's philosophy is accepted in modern management, and most would subscribe to the principle of scientific decision-making. In most business schools here is now a specialised field called Management Science (which includes Operations Research), the scientific approach is reflected everywhere: in employee selection, in evaluating incentive techniques, in plant design and construction, in accounting (e.g., cost accounting), in marketing (e.g., market analysis, market surveys), in purchasing and inventory control, in planning (e.g., the Gantt and PERT charts), in human engineering, in investment decisions, etc. As such, these theories were just extensions of so-called Scientific Management.

While Taylor cannot take credit for all of these particular applications and developments, he can be credited with helping to instil a new, scientific, way of thinking among managers. His goal was to forge a "*mental revolution*" in management and in this aim he clearly succeeded. Drucker wrote that, *"Taylor was the first man in history who actually studied work seriously".*

A second element of Taylor's philosophy of management, and the other key aspect of the mental revolution which he advocated, concerned the relationship between management and labour. At the turn of the century, the Marxian *"class struggle"* premise was accepted by managers and workers alike. It was assumed that there was a fundamental conflict of interest between labour and management, especially regarding the issue of wages and responsibilities driven by job separation and bestowed authority. i.e. the ranking of the worth of jobs in an organisation.

Taylor argued that this prevailing view was false, that at root, the interests of both parties were the same. Both would benefit, he argued, from higher production, lower costs, and higher wages, providing management approached its job scientifically. Taylor believed that there would be no conflict over how to divide the pie providing the pie were large enough.

And as such, these theories were just extensions of so-called Scientific Management.

1.5.1 JOB ANALYSIS

Following on from Taylor, the other cofounders of Scientific Management, Frank and Lillian Gilbreth [26] carried on his work, focussing on time-and-motion studies. They named their methodology the Gilbreth System and used the slogan, "*The One Best Way to Do Work*", to promote it. The Gilbreths also developed a new technique for their studies that used a motion-picture camera to record work processes. They laid the foundation of Job Analysis; understanding the behavioural requirements of work, which has not changed in over 85 years. These Time and Motion studies have been practiced from 1904 and to the present.

One of the main purposes of conducting job analysis was said to prepare job descriptions and job specifications which in turn helps hire the right quality of workforce into an organisation. The general purpose of job analysis is to document the requirements of a job and the work performed. Job and task analysis is performed as a basis for later improvements, including: definition of a job domain; description of a job; development of performance appraisals, personnel selection, selection systems, promotion criteria, training needs assessment, legal defence of selection processes, and compensation plans. The human performance improvement industry uses job analysis which, is said to ensure that training and development activities are focused and efficient. In the fields of Human Resources and industrial psychology, job analysis is often used to gather information for use in personnel selection, training, classification, and/or compensation.

It also involves determining the relative importance of the duties, responsibilities and physical and emotional skills for a given job. All these factors identify what a job demands and what an employee must possess to perform a job productively.

Henry Gantt was also an associate of Taylor. He is probably best known for two contributions to classical management theory:

1. The Gantt chart, which provides a graphic representation of events over the course of a project.
2. The Task and Bonus System, which linked the bonus paid to managers to how well they managed their employees to improve performance.

ELEMENTS OF JOB ANALYSIS

The process of job analysis involves in-depth investigation in order to control the output, i.e., get the job performed successfully. The process helps in finding out what a particular department requires and what a prospective worker needs to deliver. It also helps in determining particulars about a job including job title, job location, job summary, duties involved, working conditions, possible hazards and machines, tools, equipment and materials to be used by the existing or potential employee.

However, the process is not limited to determination of these factors only. It also extends to finding out the necessary human qualifications to perform the job. These include establishing the levels of education, experience, judgment, training, initiative, leadership skills, physical skills, communication skills, responsibility, accountability, emotional characteristics and unusual sensory demands. These factors change according to the type, seniority level, industry and risk involved in a particular job.

Job Analysis plays an important role in recruitment and selection, job evaluation, job designing, deciding compensation and benefits packages, performance appraisal, analysing training and development needs, assessing the worth of a job and increasing personnel as well as organisational productivity.

Elements are:

- **Recruitment and Selection:** The objective is to fit a right person at a right place.
- **Performance Analysis:** Job analysis is done to check if goals and objectives of a particular job are met or not.
- **Training and Development:** Job Analysis can be used to assess the training and development needs of employees.
- **Compensation Management:** deciding the worth of an employee for a particular job opening.
- **Job Designing and Redesigning:** streamline the human efforts and get the best possible output.

Therefore, job analysis is one of the most important functions of an HR manager or department. This helps in fitting the right kind of talent in the right place and at the right time. But it relies on the job being properly scoped and sufficiently described for this to be effective. Both often over emphasise some aspects and understate others. And jobs change with the current incumbent (xiii). Over time they resemble less and less the original description. When an employee leaves or changes jobs, going back to the original description may take the organisation backwards.

(xiii) But what happens when the job changes through as a result of other factors? How to retrain the worker so displaced? TWI was explicit in this in the early 1940s, in saying that any worker displaced as a result of a workplace improvement is to be re-trained and employed elsewhere.

CONCERNS ABOUT JOB ANALYSIS

Since job analysis is directly related to Taylor's interpretation of scientific management, it automatically suffers from the problems noted above.

The process of job analysis can be effective, appropriate, practical, efficient and focused but it can be costly, time consuming and disruptive for employees at the same time.

1 Difficulty of measuring human performance reliably

Human performance is, and can be affected by several factors, in particular: environmental factors which are reported [27] as being known to affect the job design to a considerable extent. They include both internal and external factors, as well as employee skills, abilities and availability. It is also reported that socio and economic factors are influential. Other factors such as ability to do other jobs. Add to this that mental abilities cannot be directly observed and that knowledge gained by a person doing a particular job is not easily reported back to the job designers only adds to the complexity in this factor of job analysis.

No process can be entirely accurate. Job analysis is no exception. The process involves a variety of methods, tools, plans and a lot of human effort. And where 'people' are involved, nothing can be 100 percent accurate. However, they may be appropriate considering various factors including organisational requirements, time, effort and financial resources. Since the entire job analysis processes, methods and tools are designed by humans only, they tend to have practical issues associated with them. The human brain suffers with some limitations, therefore, everything created, designed or developed by humans too, have some or other constraints.

2 Incentives don't work

Compensation Management: is about deciding the worth of an employee for a particular job opening and is approximate at best.

Each Job Analysis activity is generally a managed project, causing typical problems that are encountered by a job analyst while carrying out the process; Lack of Co-operation from Employees: it is time consuming, involves personal biasness, and it requires full support from management.

3 Separation of planning / management and workers

Job Analysis is carried out by job analysts / Industrial-Organisational (I-O) psychologists, usually from HR P (Human Resource Payroll), on behalf of management. Workers have no input to job analysis; it happens to them without their involvement.

The process of job analysis can be effective, appropriate, practical, efficient and focused but it can be costly, time consuming and disruptive for employees at the same time. Each Job Analysis activity is generally a managed project, causing typical problems that are encountered by a job analyst while carrying out the process; Lack of Co-operation from Employees: Time Consuming, Involves Personal Biasness, and it requires full support from management.

HUMAN RESOURCE MANAGEMENT

How is Job Analysis related to HRM?

Job analysis is the basis for human resources management, it consists of two parts: the job description and definition of how the work works. This includes the work of collecting information needed to establish job specifications (xiv), job summary, job duties and responsibilities, and information of qualification criteria, which facilitate the use of functions for other human resource management.

Job analysis is also defined as a system process to identify the skills to complete the work, responsibility and knowledge, which is an important and universal human resource management technique. It is the cornerstone of all activities for human resource management, which collects information for other human resource management practices, such as selection, training, performance appraisal, compensation design.

It enables organisations to define problem areas, identify gaps through the analysis of existing work, and design work to be more efficient, define performance incentives, and to reorganise to more flexible organisational structures

What are concerns about HRM?

By definition, therefore, the concerns we identified for Job Analysis are equally applicable to HRM.

Once work analysis has been carried out, job descriptions, work standards and a written procedures manual can be established, but there is a danger that these can become frozen in time and the organisation cannot adjust as the business context changes.

In many organisations, despite the attempt to standardise; there can remain areas of confusion departmental relationships can remain unclear, responsibilities and rights of managers are confused.

In some organisations work design still remains as informal and verbal, solely the responsibility of the line manager.

Other organisations there is little recognition of robust work design and robust processes to help them gain a competitive advantage.

The process is generally carried out by specialists, whereby the local manager is subject to their analytical outcomes as well. In other words, the local manager has only limited authority over their prescribed area of responsibility.

Current HRM remains strongly based on scientific management, and as such retains all the areas of concern that we identified for Job Analysis

(xiv) but if the people engaged in these tasks have little or no knowledge of the academic, technical intricacies or experience needed to do the job, how can they correctly specify it?

1.5.2 OPERATIONS RESEARCH

The modern field of operational research arose during World War II. [28], and in that era, operational research was defined as "*a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control*". [29]

With expanded techniques and growing awareness of the field at the close of the last war, Operational Research was no longer limited to only operational elements, but was extended to encompass equipment procurement, training, logistics and infrastructure.

Operational Research (OR) encompasses the development and the use of a wide range of problem-solving techniques and methods applied in the pursuit of improved decision-making and efficiency, such as simulation, mathematical optimisation, queueing theory and other stochastic-process models. Nearly all of these techniques involve the construction of mathematical models that attempt to describe the system. Because of the computational and statistical nature of most of these fields, OR also has strong ties to computer science and analytics. According to Peter Denning [30], the fundamental question underlying computer science is, *what can be (efficiently) automated?*

Operations Research also grew in many areas other than the military once scientists learned to apply its principles to the civilian sector. With the development of the simplex algorithm for linear programming in 1947 and the development of computers over the next three decades. Operations Research can now *"solve problems with hundreds of thousands of variables and constraints. Moreover, the large volumes of data required for such problems can be stored and manipulated very efficiently."* [31]. Modern applications of operations research include city planning, football strategies, emergency planning, optimising all facets of industry and economy, and undoubtedly with the likelihood of the inclusion of terrorist attack planning and definitely counter-terrorist attack planning. Margaret Rouse [32] adds; that in operations research, problems are broken down into basic components and then solved in defined steps by mathematical analysis.

Disciplines that are similar to, or overlap with, operations research include statistical analysis, management science, game theory, optimisation theory, artificial intelligence and network analysis. All of these techniques have the goal of solving complex problems and improving quantitative decisions, with a widespread emphasis on incentives, agency theory; job analysis in HR; departmentalisation and the functional management form; management by objectives; goal setting. And such elements of HR as training, staffing, and testing are still in vogue, and taught in higher education, seeing the organisation as a machine and not a complex, adaptive system that is not amenable to linear control. It is an open, evolving and complex system and needs to be managed accordingly.

ELEMENTS OF OPERATIONS RESEARCH

There are three primary characteristics of all operations research efforts:

1. Optimisation- The purpose of operations research is to achieve the best performance under the given circumstances. Optimisation also involves comparing and narrowing down potential options.
2. Simulation- This involves building models or replications in order to try out and test solutions before applying them.
3. Probability and statistics- This includes using mathematical algorithms and data to uncover helpful insights and risks, make reliable predictions and test possible solutions.

The field of operations research provides a more powerful approach to decision making than ordinary software and data analytics tools. Employing operations research professionals can help companies achieve more complete datasets, consider all available options, predict all possible outcomes and estimate risk. Additionally, operations research can be tailored to specific business processes or use cases to determine which techniques are most appropriate to solve the problem.

Operations research can be applied to a variety of use cases, including: Scheduling and time management, Urban and agricultural planning, Enterprise resource planning (ERP) and supply chain management (SCM), Inventory management, Network optimisation and engineering, Risk management.

Claimed Advantages of Operations Research

Operations research is said to provide objective data, identifying which aspects of a business are cost effective and profitable and which use more time and resources than necessary. The numbers are clean and clear, and can provide information that isn't always apparent when people are just doing their work.

For example, tracking worker productivity relative to pay grade and equipment upgrades could help to calculate whether an extra investment in payroll or in infrastructure pays off in increased output. Similarly, examining the correlation between the number of people on the production floor, the types of products being produced and the amount produced per person per hour provides information for determining the optimum number of people to schedule at once for different products. On the whole, OR works best in big projects, in logistics, scheduling and planning.

According to Heinze, [33] the application of these OR models to the corporate sector became known as “management science”. In 1967 Stafford Beer [SB] characterized the field of management science as "the business use of operations research".

Wetherbe [34] says*, A systems analyst who contributes in the area of DSS (xv) must be skilled in such areas as management science (synonymous with decision science and operation research), modelling, simulation, and advanced statistics.*

But the use of sophisticated mathematics does not necessarily make the practice of management “scientific”.

(xv) DSS – Decision Support System

CONCERNS ABOUT OPERATIONS RESEARCH

1 Difficulty of measuring human performance reliably

Operations research gives objective data, identifying which aspects of a business are cost effective and profitable and which use more time and resources than necessary (xvi). Despite the complexity of the mathematics involved, OR still uses a number of starting assumption and approximations to obtain smoothed results.

Organisations are mainly concerned with day to day issues of running a business, they may have neither the resources nor the interest in using complex mathematics to solve tangible operations issues.

However, intangible variables such as kindness and quality of life also play into business decisions, and operations data typically doesn't capture their importance. The importance of operations research in modern business management can make business decisions impersonal, emphasising the numbers at the expense of the human element. And there is the customer element to consider.

Some operations research is also quite sophisticated mathematically. This is an advantage because a skilled and knowledgeable researcher can draw nuanced conclusions. However, if you're mostly concerned with the day to day nuts and bolts of your business, you may have neither the resources nor the interest in using complex mathematics to solve tangible operations issues.

2 Incentives don't work

Tracking worker productivity relative to pay grade and equipment upgrades may on the surface appear to help managers to calculate whether an extra investment in payroll or in infrastructure pays off in increased output. However, as we describe in Appendix 2, the actual outcome from increases in pay is not a successful pre-cursor to greater performance. It is more likely to have the opposite effect. See also 2.8 on what managers need to provide.

3 Separation of planning / management and workers

Operations Research is carried out by skilled and knowledgeable researchers, who can draw peripheral interconnections on behalf of management.

Workers have no input to operations research; it happens to them without their involvement.

(xvi) problems can arise if cuts are made to items which appear to be costly, but which may be essential to the customer.

1.6 SHEWHART AND SQC

The first person to apply two of the basic scientific methods to industrial production was Dr Walter Shewhart. After obtaining his doctorate in physics from the University of California, Berkeley, he joined the Western Electric Company Inspection Engineering Department at the Hawthorne Works in 1918, where industrial quality was limited to inspecting finished products and removing defective items.

In 1924, Western Electric were having trouble with improving the quality of production of telephones and the reliability of buried cable amplifiers. Shewhart saw the importance of reducing variation in the manufacturing process. He understood that continually adjusting the process in response to every signal that might indicate non-conformance, actually increased the product variation and degraded quality.

He began to develop his theories about the quality of manufactured products and proposed statistical methods for examining, understanding and showing how to control quality of products.

RELIABILITY / REPRODUCABILITY OF DATA

Relating back to our key scientific method element; interoperability of data, the theme underlying all of Shewhart's teachings is an understanding of the reproducibility, accuracy and precision of measurement. A fundamental requirement underlying accuracy and precisionist is the concept of an operational procedure.

Shewhart recognised that all of the materials and processes that they were dealing with were subject to variation and this was due to of assignable-cause and chance-cause variation. He proposed the control chart as a tool for distinguishing between the two. He noticed people could be making one, of two, mistakes in interpreting data;

> ***Mistake 1***. There were some outcome measurements being treated as though they were signals for action, when actually they were noise.
>
> ***Mistake 2***. Other outcome measurements were being treated as if they came from system noise, when in practice they were a signal for action.

Shewhart stressed that the purpose of the control chart is to bring a production process into a state of statistical control. By "*weeding out assignable causes of variation, we go to the feasible limit in assuring uniform quality.*" Where there is only chance-cause variation, the process can be said to be under control and keeping it in control enables us to predict future output and to manage a process economically.

How to determine these limits? Obviously, the choice has to be empirical. He says: "*it is reasonable to choose control limits based on some statistic where the associated probability of error is economic. Experience indicates that setting limits at ± 3σ will be an acceptable economic value.*"

Shewhart's charts were adopted by the American Society for Testing and Materials (ASTM) in 1933 [35] and advocated to improve production during World War II in American War Standard Z1.1-1941 [36] Guide for Quality Control, and Control Chart Method of Analysing Data.

1.6.1 PROBLEMS WITH SQC or SPC

Shewhart Control Charts provided a revolution in obtaining control of the variability of products and materials. In his work (p250), he touches on the relation between control limits and tolerance limits, and that designs should include specification of target value and a standard deviation. He did not expand on this and it was left to Dr Genichi Taguchi to take this further in his concept of Robust Quality.

There is a common belief that high levels of quality cost more. Even to the extent that achieving high levels of quality is unnecessary, and not wanted by the customer. This is unfortunately not correct and even small deviations away from the desired target can and do cost the organisation financially more than is apparent. Many times, more.

As far back as Taylor, the acceptability of items produced by a process were required to lie between an upper specification and a lower specification; generally measured by means of GO / NOGO gauges. The concept of lower and upper limits became imbedded in the design and manufacture of massed produced items; and has found its way into service delivery.

The Taguchi approach is to say that any deviation from the target (most desirable) value will incur some current and future loss in an assembled component (or delivered service), and will be perceived as less desirable by the customer, and as wider losses in society. As the deviation grows from the most desirable value the customer will become more dissatisfied. In other words, the perception of quality does not follow a cliff edge model; acceptable, until you fall off the cliff. It is a gradual, and growing dissatisfaction with the product (or service) the further it is away from target (xvii). The underlying message is that your objective is to be on target with minimal variation – Wheeler [37].

For further detail and information on this subject, and Yoshida's criterion on Acceptability v Desirability see Appendix 3

1.6.2 HYPOTHESIS TESTING – The Shewhart cycle

The second of our key elements of scientific methods is Hypothesis testing, which is fundamental to Shewhart's thinking. He improved Taylor's scientific management method in the 1930s, introducing the plan-do-study-act or the PDSA cycle. This came about as he saw that there was much room for improvement specifically in Taylor's definition of his scientific management method.

In *Statistical Method from the Viewpoint of Quality Control* (1939) Shewhart [38] starts by defining the three stages of a quality control process; the ***specification*** of what is wanted, the ***production*** of things to satisfy the specification, and the ***inspection*** (xviii) of things produced to see if they satisfy the specification. Later he thinks that these three steps are a sequence ordered in relation to the production process. And, in fact, these three steps must go in a circle; see fig 1 below:

(xvii) This was definitively demonstrated to Ford in 1983 and as recognised by John Betti, VP Powertrain and Chassis Operations. See Neave in Appendix 3.

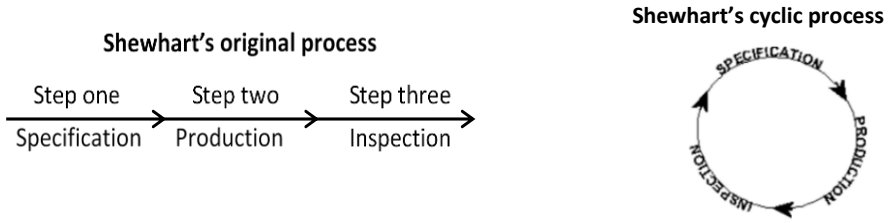


Fig 1 – from Shewhart [38] pp35. See also Moen & Norman [39]

In the Epilogue to the book, he points out that these three steps in mass production could be *put in parallel with the three fundamental steps in scientific method……so visualising the act of control as a scientific one*. see table 1 below:

Mass Production	**Scientific Method**
Specification	*Hypothesis*
Production	*Experiment*
Inspection	*Test of Hypothesis*

Table 1 from: Shewhart, Walter A., 1939, *Statistical Method from the Viewpoint of Quality Control [pp149]*, DoA, Washington, DC. Reprinted by Dover 1939. [40]

While at Hawthorne, Shewhart met and influenced W Edwards Deming who went on to champion Shewhart's methods.

In 1950, Deming received an invitation to teach The Application of Statistics to Quality Improvement from the Union of Japanese Scientists and Engineers (JUSE) under the leadership of Ichiro Ishikawa.

Joseph Juran also worked at Hawthorne from 1924 to 1941 and was influenced by Shewhart. Shewhart, Deming, and Juran are often considered to be the three founders of the quality improvement movement.

Two of Shewhart's contributions continue to influence the daily work of quality—namely, control charts and the Plan–Do–Study–Act (PDSA) cycle.

(xviii) for processes in the Service sector, use a) what is the service, b) the customer delivery process, c) actual customer needs met – check on the quality of the process deployment.

1.7 TWI (TRAINING WITHIN INDUSTRY)

After the Nazi invasion of France in June 1940, the US realised that a second world war was inevitable.

The USA was ill prepared for war. A huge step up in manpower and equipment was needed even though they were not embroiled in the conflict at that time.

A big danger was that the involvement of US troops in the war meant that the majority of American men of working age, and working mainly in industry, would be recruited into the army. As such they were going to be needed to be replaced by other people. This would include people, who had never before worked in industry. They were mainly women, men who were too young to be recruited into the army and administrative staff.

The United States government formed the Bureau of Training War Manpower Commission to help industry quickly and reliably support the war effort by boosting industrial production by boosting skills.

The Training Within Industry (TWI) [41] Program was a resounding success: By the end of the war, the USA had out produced Germany and Japan by 200% !!

> 2,710 Liberty Ships.
>
> 18,500 Consolidated B24 Liberator fast, long-range Bombers were built, together they eventually ended the battle of the Atlantic by May 1943.
>
> 10,000 Douglas DC3 Dakota; as C37 and C54 cargo aircraft were the backbone of logistic support to operation Overlord.
>
> 14,000 P51 Mustang fighters protected the bombers over enemy territory.
>
> The bulk of these aircraft were built in automotive and general engineering plants staffed with people with no previous experience of aircraft manufacture.

Three training programs, frequently called "J" programs (J stands for "jobs"), comprise Training Within Industry (TWI), along with a fourth program called Program Development, and a fifth titled Union Job Relations. See Jim Huntzinger [42].

The three 'J' programs were:

Job Instruction (JI) teaches supervisors how to instruct the people doing the jobs.

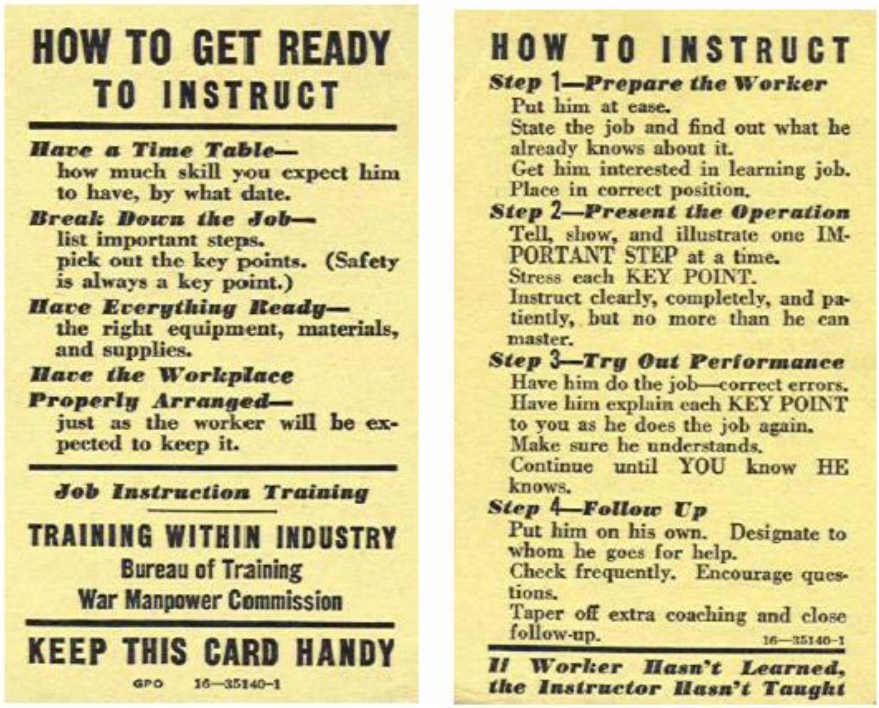
Job Methods (JM). helps supervisors acquire skills in improving methods.

Job Relations (JR). to help supervisors acquire leadership skills.

Each J program had a two-sided pocket card that supervisors could use for quick reference.

And most impressively — the TWI Job Instruction teachings have survived to this day almost completely unchanged. The pocket card carried around by Toyota supervisors today is almost identical to the original pocket card [see Figs 2 and 3] distributed by the U.S. government in the early 1940s. See also table 2 for Charles Allen's 4 step method.

The success of the Training Within Industry program resulted from the fact that each of its methods was itself based on a cycle of Plan-Do-Study-Act, an Improvement and Learning Cycle, itself based on Hypothesis testing. Which is: If… - Then…, i.e. Cause and Effect analysis.



HOW TO GET READY TO INSTRUCT

Have a Time Table—
how much skill you expect him to have, by what date.

Break Down the Job—
list important steps.
pick out the key points. (Safety is always a key point.)

Have Everything Ready—
the right equipment, materials, and supplies.

Have the Workplace Properly Arranged—
just as the worker will be expected to keep it.

Job Instruction Training

TRAINING WITHIN INDUSTRY
Bureau of Training
War Manpower Commission

KEEP THIS CARD HANDY

GPO 16—35140-1

HOW TO INSTRUCT

Step 1—Prepare the Worker
Put him at ease.
State the job and find out what he already knows about it.
Get him interested in learning job.
Place in correct position.

Step 2—Present the Operation
Tell, show, and illustrate one IMPORTANT STEP at a time.
Stress each KEY POINT.
Instruct clearly, completely, and patiently, but no more than he can master.

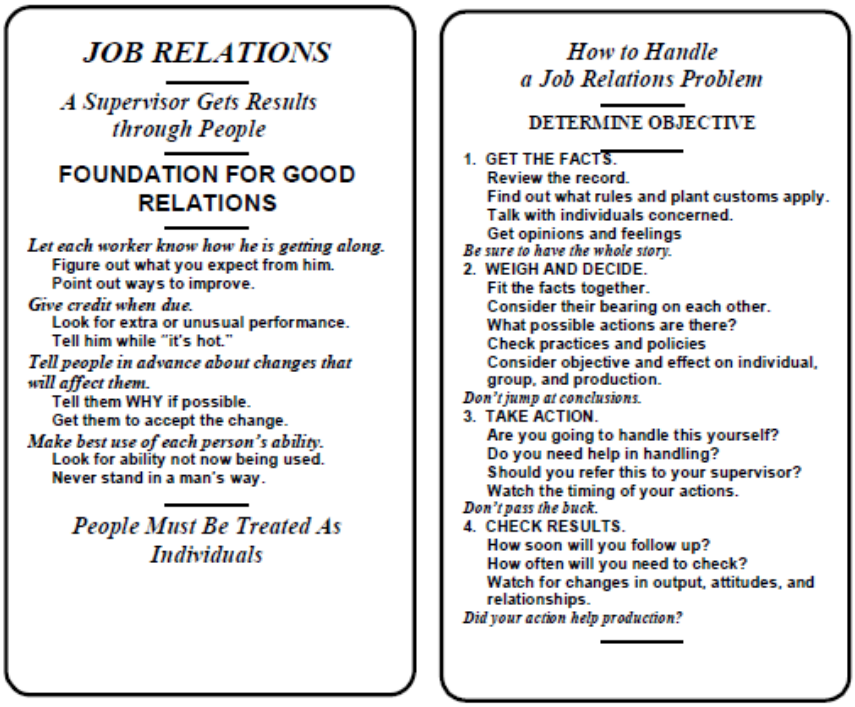
Step 3—Try Out Performance
Have him do the job—correct errors.
Have him explain each KEY POINT to you as he does the job again.
Make sure he understands.
Continue until YOU know HE knows.

Step 4—Follow Up
Put him on his own. Designate to whom he goes for help.
Check frequently. Encourage questions.
Taper off extra coaching and close follow-up.

16—35140-1

If Worker Hasn't Learned, the Instructor Hasn't Taught

Fig 2: **TWI Job Instruction Card** - SOURCE: War Production Board, Bureau of Training, Training Within Industry Service, 1944, *Job Instruction: Sessions Outline and Reference Material* (Washington D.C.: U.S. Government Printing Office), Inside back cover. And as reproduced in: *The Roots of Lean : Training Within Industry: The Origin of Japanese Management and Kaizen*. By Jim Huntzinger of Flexwareinnovation.com, Indiana, USA.



JOB RELATIONS

A Supervisor Gets Results through People

FOUNDATION FOR GOOD RELATIONS

Let each worker know how he is getting along.
Figure out what you expect from him.
Point out ways to improve.

Give credit when due.
Look for extra or unusual performance.
Tell him while "it's hot."

Tell people in advance about changes that will affect them.
Tell them WHY if possible.
Get them to accept the change.

Make best use of each person's ability.
Look for ability not now being used.
Never stand in a man's way.

People Must Be Treated As Individuals

How to Handle a Job Relations Problem

DETERMINE OBJECTIVE

1. GET THE FACTS.
   Review the record.
   Find out what rules and plant customs apply.
   Talk with individuals concerned.
   Get opinions and feelings
Be sure to have the whole story.
2. WEIGH AND DECIDE.
   Fit the facts together.
   Consider their bearing on each other.
   What possible actions are there?
   Check practices and policies
   Consider objective and effect on individual, group, and production.
Don't jump at conclusions.
3. TAKE ACTION.
   Are you going to handle this yourself?
   Do you need help in handling?
   Should you refer this to your supervisor?
   Watch the timing of your actions.
Don't pass the buck.
4. CHECK RESULTS.
   How soon will you follow up?
   How often will you need to check?
   Watch for changes in output, attitudes, and relationships.
Did your action help production?

Fig 3: **TWI Job Relations Card** - SOURCE: Adapted from Bird McCord, "*Job Instruction*," Robert L. Craig (ed.), 1976, *The Training and Development Handbook – A Guide to Human Resource Development*, 2nd ed. (New York: McGraw-Hill), p. 32-22.and as reproduced in: *The Roots of Lean : Training Within Industry: The Origin of Japanese Management and Kaizen*. By Jim Huntzinger of Flexwareinnovation.com, Indiana, USA.

THE 4 STEP METHOD (TWI is simply the applied scientific method)

Charles Allen's 4Step Learning Process	TWI			PDSA Cycle	Scientific Methods
	Job Instruction	**Job Methods (Improvement)**	**Job Relations**		
Preparations	Prepare the Worker	Breakdown the Job	Get the Facts	**Plan** observe data / reality; decide on a problem; define it	Observation and Description
Presentation	Present the Operation	Question every Detail	Weigh and Decide	**Do** Analyse problem, propose countermeasure	Formulate an Hypothesis
Application	Try Out Performance	Develop New Methods	Take Action	**Check** do Countermeasure check result	Make Prediction
Testing	Follow up	Apply New Method	Check Result	**Act** standardise or start cycle over	Test Prediction by Experiment

Table 2 - The Charles Allen 4 Step Method [43] compared with the TWI method, and the PDSA cycle and as implemented in a Kaizen (Scientific Methods) approach. An original table was compiled by Jim Huntzinger of Flexiwareinnovation in his paper *The Roots of Lean : Training Within Industry: The Origin of Japanese Management and Kaizen.* See also Operational Excellence Consulting - Singapore. [44]

The 4-step method, originally developed by Charles Allen was adapted for the TWI programme as the basis of the three 'J' Cards. The interrelationships are set out under the TWI heading. The scientific methods as used in a Kaizen approach, of which the PDCA (and PDSA) cycles are the fundamental basis are added for comparison and to show the continuity between the original TWI material as developed in the USA in the early 1940s, as taught to the Japanese in the early 1950s and as subsequently developed by them into the production systems in wide use there today.

The method also teaches how to use data and evidence in context.

This contrasts with the so-called Scientific Management of F W Taylor which had similar aims but emphasised the separation between management, who did the planning and operatives who did the work. It also emphasised measure everything in order to cut costs. But measuring everything will increase your costs. [45]

Both Shewhart and Deming made contributions to TWI.

Shewhart served as a consultant in the War Department during World War II and the resultant American War Standards helped in the productivity efforts.

Deming worked for the U.S. Census Bureau as an advisor in statistical sampling techniques. He began the use of statistically based survey techniques in the 1940 census, which greatly improve the accuracy and lowered the cost of the census. He also introduced statistical quality control techniques to improve the process of tabulating and summarising the results. (It was the first use of statistical methods of quality improvement in a white-collar {service} environment.)

In 1943 under the direction of W. Allen Wallis of Stanford University, Deming begins The Stanford Statistic Training Program, training almost 2,000 people in two years, using the Shewhart Cycle for Learning and Improvement and the PDSA Cycle.

At the end of the war, there was more demand than capacity in post-was America, and TWI just fell out of favour. U.S. companies, fueled by growing markets and minimal competition, spent their energies elsewhere. When the TWI program was discontinued (November 1945), they returned to "business as usual ", propelled by both the removal of the demands of the war effort, and by the embedded skill sets of the returning soldiers who had not been trained in the TWI methods.

Simply, they ignored the gains made under TWI and went back to doing what they had done before.

1.8 SUMMARY – part 1

This part looked at the early twentieth century up to the end of World War II.

In the first strand of our paper, we started with Fredrick Winslow Taylor who in 1912 formulated his model of 'Scientific management', based on a study of working practices and in which he sought a '*one best way*' to perform a task. His ideas caught the imagination of industrialists and a first formal structure for the management of an organisation was born.

We have examined the elements of the "scientific method" that can still be seen everywhere. The unspoken assumption in most Western organisations is the validity of Taylorism and its extensions

The problems associated with Tayloresque theories and practice have been explored, along with their initial derivatives, job analysis and operation research. This has demonstrated their pervasive influence through widespread attempts to measure human performance with an emphasis on incentives; separating management from action; through a belief in standardised output (xix), itself based on a project driven mentality with a heavy focus on cost.

The second strand started with Shewhart and SQC. His pioneering work used the well-known scientific methods of interoperability of observations/data, and the well-established concept of hypothesis testing.

We outlined the major effort to build US production and quality in World War II, under the banner of Training for Work in Industry (TWI). This laid the foundations for management practice, training for employees and mutual cooperation between business and workers.

(xix) In this context, Standardised Output refers to an externally derived 'Best Way' of doing something, which invariably does not involve input from those with experience of producing the output and which would form a critical component in defining Standardised Work within a Kaizen and Lean environment.

PART TWO:

THE APPLIED SCIENTIFIC METHOD

2.1 THE JAPANESE LEARN FROM AMERICA

To look at this topic, we need to revert back to the first quarter of the twentieth century. At that time, Toyoda (i) began in the Japanese weaving industry when Sakichi Toyoda invented the world's first automatic loom and, subsequently, set up the Toyoda Spinning and Weaving Company in 1918. His invention reduced defects and increased yields since a loom stopped and would not go on producing imperfect fabric and using up thread after a problem occurred. This principle of designing equipment to stop automatically and call attention to problems immediately (jidoka) remains crucial to the Toyota Production System today.

In 1921, the Toyoda Boshoku plant in Shanghai (Toyoda Boshoku Sho) was completed, it was decided that Sakichi's son Kiichiro should visit the United States and Europe on a study tour.

Once in the United States, the party spent the rest of August that year visiting cotton plantations and related facilities, as well as textile factories. The group then left for England, arriving in London in the October.

In England, they again devoted their time and energy to visiting cotton processing facilities and textile factories. Kiichiro went to receive training at Platt (ii) for two weeks from January 1922, at Oldham, outside Manchester. While at Platt and studying the processes and methods for manufacturing spinning machines, Kiichiro also studied cop-changing automatic looms.

Later, Kiichiro would say of this trip, *"When I went overseas a few years back, I wanted to find a good automatic loom, but despite all my searching and investigations, I came back empty handed,"* alluding to the fact that one of the purposes of the trip had been to investigate automatic looms in England.

However, the training Kiichiro received at Platt was, certainly valuable when it came time to establish The Toyoda Automatic Loom Works.

The Toyoda loom impressed the Platt Brothers, so much that, in 1929, they bought the production and sales rights for £100,000. Sakichi gave those proceeds to his son, Kiichiro, to develop automotive technology at Toyoda.

In 1933, Kiichiro Toyoda established an auto division within Toyoda Loom Works, which released a prototype vehicle two years later. He directed the engine casting work and discovered many problems in the manufacturing processes. He decided he must stop having to repair poor quality by intensely studying each stage of the process.

In 1936, when Toyota won its first truck contract with the Japanese government, his processes hit new problems and he developed the "Kaizen" (continuous improvement) teams, bringing together teams that included everyone from factory floor to the CEO.

(i) the Toyota company's founding family name.

(ii) https://en.wikipedia.org/wiki/Platt_Brothers

Kiichiro spent a further year in Detroit studying Ford's manufacturing system and adapted what he had learned to the production of small quantities of automobiles. He reasoned that the company could save money if parts and components could be delivered to the assembly line just in time to be installed on the car being built. He also changed the traditional physical layout of the plant so that machine tools were grouped along the flow of production. That made the supply line shorter and meant parts could get into the assembly process sooner. He then began convincing suppliers to cooperate (iii) in his just-in-time system.

Eiji Toyoda also visited Detroit to further study manufacturing at Ford. He was particularly impressed with their quality improvement activities. He began to implement the flow production concepts he had seen.

These visits augmented the early concepts of the Toyota Production System.

(iii) this later developed into the ***Keiretsu***, whereby suppliers and the company co-operate on many aspects of the production and supply of components.

2.1.1 AMERICA EXPORTS KNOWHOW TO JAPAN

In 1947 General MacArthur's Supreme Command of Allied Powers (SCAP) engaged Deming to help Japanese statisticians assess the problems of nutrition and housing in their devastated country and to prepare for a census to be taken in 1951. Unlike other American experts brought to Japan, Deming showed respect for the Japanese peoples and their culture; he treated them as colleagues instead of vanquished enemies and learnt first-hand about Japanese culture.

About this time, the offices of the Allied occupation (iv) were about to place an order of vacuum tubes to Toshiba. One of their leading quality engineers Eizaburo Nishibori recalled that the American officers wanted to see a *'control chart'* from the manufacturing process being used to produce their order. No one at Toshiba knew what it was. "*You don't know a control chart? How do you plan to manage quality*?" Nishibori [1] remembers replying, "*If we, engineers at Toshiba, don't know it, most likely no one in Japan knows."* (Statistical methods were part of TWI).

Soon after this incident, the GHQ officers began giving lectures to their Japanese vendors, using QC books procured from their Washington D.C. office. Only two students attended at first, Nishibori from Toshiba and Nishio from NEC, with neither of them comprehending much of what was taught.

Later others joined, but a doubt lingered about the usefulness of QC and such seminars. "*It looks like statistics, is QC statistics?"* the students asked. This was the first time the Japanese ever heard of "*Statistical Quality Control (SQC).*" Nishibori remembered thinking, "*Hmm, is this what Americans are doing now? How do I find out more?"*

Having to rebuild their industrial base, Japanese companies embraced the TWI teachings in a big way. TWI just fell out of favour in post-war America. But, TWI did not die! The TWI Job Instruction teachings, as found in the 'J' Books used to great effect in America from the early 1940s have survived to this day almost completely unchanged in Japanese companies.

TWI was introduced in Japan during post-war rebuilding where it played a key role in quickly reestablishing their peaceful industrial base. Between 1950 and 1960, Toyota used TWI to train its employees as part of the emerging Toyota Production System, the world's first Lean Manufacturing Program.

TWI is an integral element of today's Lean Manufacturing and Kaizen strategies.

(iv) based on the realisation by Gen Douglas MacArthur, that if Japan was not rebuilt and its industries re-built it would descend into a rouge state. And he quickly grasped that Japanese industry and telephony was derelict, that to communicate en-masse a national radio system had to be built, and in some haste.

In 1950 Deming received an invitation to teach the application of statistics to quality improvement from the Union of Japanese Scientists and Engineers (JUSE), sponsored by the Keidanren, the most prestigious society of Japanese executives, under the leadership of its chairman, Ichiro Ishikawa (also president of JUSE).

Deming stressed the importance of constant interaction among design, production, sales, and research and that the four steps should be rotated constantly, with quality of product and service as the aim. Deming's Shewhart cycle was modified slightly in 1950 [2]. The Japanese called this the "Deming wheel". See Fig:1 [2] [3] Moen and Norman

Fig 1: The Deming Wheel and its developments from: Moen and Norman

Improvement, combines management thinking with statistical analysis. The Japanese found this interesting and re-designed it as the PDCA cycle; See Fig 2.

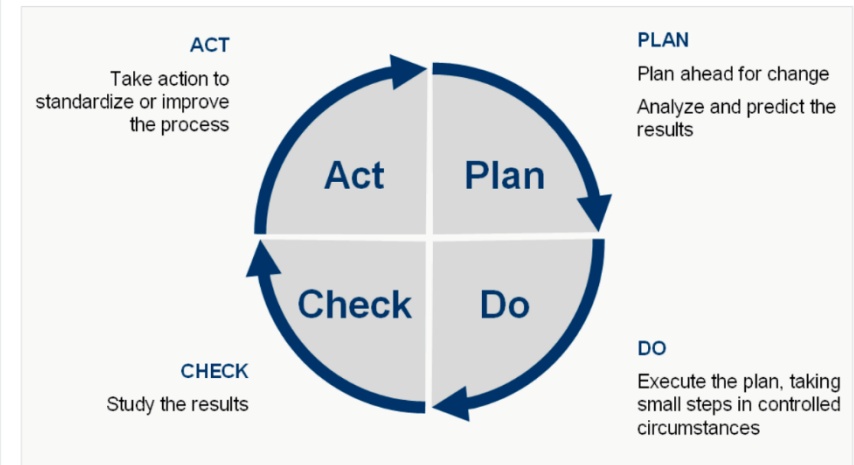


Fig 2: The PDCA as re-designed by the Japanese.

The PDCA cycle and the QC story (aka A3 Report (v)), together with the seven basic tools (vi) became the foundation for improvement (kaizen) in Japan right through to the present day.

(v) so called after the international paper size on which it fits (largest that at that time could be sent by fax), providing a visual description of progress of a given study, available to all.

(vi) Tools are only there to be used when needed. It is the philosophy of the process of investigation that is of essence.

Deming was never fully at ease with 'Check' in the original cycle, and continued to develop the cycle and its implications for management. During the series of four-day international seminars that Deming gave between 1990 and 1993, he had slightly modified this to the PDSA cycle for learning and improvement, combining management thinking with statistical analysis. See Fig 3.

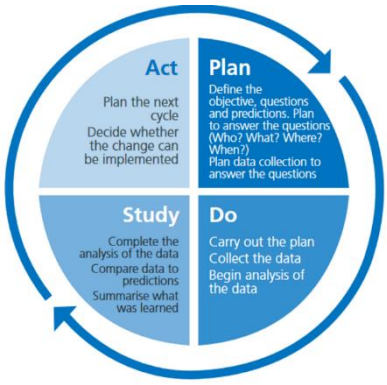


Fig 3 - The PDSA cycle of continual improvement, and root cause analysis study.

It has the following four stages:

- **Plan:** identify what can be improved and what change is needed
- **Do:** implement the design change
- **Study:** measure and analyse the process or outcome
- **Act:** if the results are not as hoped for

This cycle is used to make changes that lead to improvement in a manner of continual quality improvement. This is a never-ending process. After the easy low-cost changes are made (the low hanging fruit harvested), the cycle process is repeated for another step, task, or process in the microsystem or system. After a period of time, other changes may result in the original process having an opportunity for improvement again.

In parallel, Deming, through JUSE was teaching Statistical and Scientific methods to the Japanese in the early 1950s. The importance of Deming's teachings in Japan should not be overlooked for two reasons: firstly, the Japanese engineers and scientists realised the importance of quality and the usefulness of statistical techniques (vii) to improve quality; at the same time, they understood and demonstrated, that quality is not a cost, it actually reduces costs. And secondly, what would later become their competition, went back to 'business as usual' effectively leaving the market place doors open.

(vii) People engaged in transformation exercises often talk about a *trigger moment*, the moment when the transforming organisation realises that something has to change. Often, these triggers can be hard to identify and surface as there can be great inertia to keep them suppressed. It is said that modern warfare is a production battle; the side that out produces the other side and as such controls its losses wins. The question is, did the engineers in Japan after the war realising that the USA had used statistical techniques as a core element of their capability, became determined to do the same? We may never really know, but they had some of the best American teachers in the theory and practice of these techniques.

We should also mention the contributions of Taiichi Ohno whose work at Toyota laid the basis of Lean Production. Kaoru Ishikawa [4] who pioneered Quality Circles and Quality Tools, he also championed the use of the fishbone, cause and effect diagram that still bears his name. His synthesis of the philosophy contributed to Japan's ascendancy as a quality leader.

Genichi Taguchi expanded SQC to the concept of robust quality - ***on target with minimal variation***. Taguchi's Loss Function cogently argues that the losses incurred from any deviation from that target value are experienced not only within the organisation but across society. This also leads to the approach to the adaptive organisation.

TWI is an integral element of today's Lean Manufacturing and Kaizen strategies.

In summary, the systems and methodologies still used extensively in Japan today were developed and refined in the USA, and then exported to Japan after WW II.

TWI was introduced in Japan during post -war rebuilding where it played a key role in quickly re-establishing their peaceful industrial base with the goal of preventing World War III.

Between 1950 and 1960, Toyota used TWI to train its employees as part of the emerging Toyota Production System, the world's first Lean Manufacturing Program.

2.2 TOTAL QUALITY MANAGEMENT

Japanese application of these methods had significant, and undeniable, results; dramatic increases in Japanese product quality and productivity. Their success in exports of automotive products, motorcycles, electronic goods, cameras, etc. is well documented.

To give one example of this rapid growth; it took 20 years for them to produce automobiles which were acceptable to the US market. Honda and Datsun (Nissan) started to export to USA in 1969, others followed and sales grew rapidly. 10 years later in 1979, 20% of US automobile sales were imports from Japan! This was bound to cause a reaction.

Firstly, under pressure from the Reagan Administration, Japan agreed to import quotas. In addition, Honda, Toyota, Nissan and Mitsubishi built manufacturing plants in USA, between 1982 and 1984 (viii). In 2019 Japanese car makers supplied circa 40% of the US market!! Most of the manufacturing was in the USA.

Second, self-examination; on June 24th 1980, NBC broadcast a special program in prime time: *"If Japan Can, Why Can't We?".* The message in this broadcast was a focus on using management practices which centred on delighting customers, respecting and involving employees whilst using data and statistical tools to continually improve.

This led to the spread of the quality movement. In the late 1970s and 1980s, U.S. producers scrambled to adopt quality and productivity techniques that might restore their competitiveness. Deming's and other's approach to quality control came to be recognised in the United States, and Deming himself became a sought-after lecturer and author. This general approach became known as Total Quality Management, although Deming himself never used the term to describe his teachings. This became a staple "fad" of American enterprise by the late 1980s. But, there was a lack of understanding of, and inconstancy in the deployment of the TPS in the USA, in partnership with Toyota in the joint venture 'NUMMI' at Fremont. This experiment changed (temporarily) the fate of the worst-performing GM auto plant. [5]

At that time, the US Department of Defense (DOD) needed to maintain a technological edge over its adversaries. Total quality management (TQM) was chosen as the management tool to help the U S A achieve this. The DOD described TQM as:

"A philosophy and a set of guiding principles that represent the foundation of a continuously improving organisation. It is the application of quantitative methods and human resources to improve the material and services supplied to an organisation, all the processes within an organisation, and the degree to which the needs of the customer are met, now, and in the future. It integrates fundamental management techniques, existing improvement efforts, and technical tools under a disciplined approach focused on continuous improvement" (Department of Defense Directive 5000.51-G, 1989). [6]

(viii) Mazda isn't missing, they co-share three plants in US with Ford under a long-standing relationship.

There are many definitions of TQM, according to ASQ (ix), the 8 principles of total quality management are;

1. **Customer-focused:** The customer ultimately determines the level of quality.
2. **Total employee involvement:** All employees participate in working toward common goals.
3. **Process-centred:** A fundamental part of TQM is a focus on process thinking. The steps required to carry out the process are defined, and performance measures are continuously monitored in order to detect unexpected variation.
4. **Integrated system:** Although an organisation may consist of many different functional specialties often organised into vertically structured departments, it is the horizontal processes interconnecting these functions that are the focus of TQM
5. **Strategic and systematic approach:** A critical part of the management of quality is the strategic and systematic approach to achieving an organisation's vision, mission, and goals.
6. **Continual improvement:** Continual improvement drives an organisation to be both analytical and creative in finding ways to become more competitive and more effective at meeting stakeholder expectations.
7. **Fact-based decision making:** In order to know how well an organisation is performing, data on performance measures are necessary.
8. **Management Purpose:** an integrated system connects business improvement elements in an attempt to continually improve and exceed the expectations of customers, employees, and other stakeholders.

The best summary definition of TQM, is the one set out by The Deming Prize Committee of JUSE which defines TQM as follows:

> *a set of **systematic activities carried out by the entire organisation to effectively and efficiently achieve company objectives** so as to **provide products and services** with a level of **quality** that satisfies **customers**, at the appropriate time and price.*

McCarthy and Eishennawy (refer to Total Quality Management Guide; *Department of Defense Directive 5000.51-G, 1989)* [6] reviewing how the DoD is planning to implement TQM, make it clear that TQM is more than a technique, rather a philosophy based on Deming's 1982 book – "Out of the Crisis" [7]. *To accomplish the transformation to TQM, everyone must think about the satisfaction of the customer as their final, team-oriented goal, and use the Shewhart Cycle to accomplish the transformation*.

(ix) American Society for Quality

2.2.1 TQM FAILS TO STICK

In 1968, the Japanese named their approach to total quality "*Companywide Quality Control*." (CWQ) or TQC. It is around this time that the term quality management systems arise. The Deming Prize Committee of JUSE translate this into TQM for the overseas version.

Given the spectacular success in Japan with CWQ, it is disappointing that TQM achieved only moderate success in the West. Some general reasons that are cited for the lack of conspicuous success of TQM include:

- Too many different, fuzzy versions of TQM
- No clear definition of the rationale for TQM.
- No clear understanding of the benefits of TQM.
- Lack of high-level management commitment and involvement.
- It required managers to transform themselves and the culture of their organisations.
- Education.
- Just another "fad" to improve quality.
- Another generally held belief is that achieving registration to ISO-9000 is sufficient to achieve a quality organisation!

The reaction was patchy. 'Quality Circles', 'SPC', 'Just in Time' etc. were easy to grasp superficially. What blocked any real progress, beyond that which is easily attained, was the firm resistance of management collectively to break with Taylorism.

According to Juran, incorporating a quality management system can save time and money, and has many advantages over not doing so. However, several myths have arisen regarding potential drawbacks to using such a system, which we'll take a look at here:

Managing for quality is cost-prohibitive

Managing for quality does have some sizable up-front costs. However, the benefits far outweigh the costs when it comes to the types of problems that get solved by well-educated employees. The costs of poor-quality start melting away, customers are happier, and employees inevitably are happier. Leaders today have to seriously ask themselves this question: can we afford to *not* manage for quality? The answer is no if you want to survive.

Only big companies use quality management

No matter the size, the number of locations, or total employees, every company should be tracking and controlling processes, managing guidelines, and adhering to requirements.

Managing for quality is something only technical professionals can do

Managing for quality is something that everyone in your organisation should be involved with! The best way to foster change in an organisation is to make sure all involved understand what is expected of them and have the resources they need to get there. Spread a quality mindset throughout your organisation and remember that improvement happens step by step, or not at all.

Grant, Shani and Krishnan [8] find that TQM calls for systemic changes in management practice, including the redesign of work, the redefinition of managerial roles, the redesign of organisational structures, the learning of new skills by employees at all levels, and the reorientation of organisational goals. Implementation of TQM therefore provides challenges similar to those involved in the management of other revolutionary transitions.

TQM represents a challenge not only to conventional management practices but also to the assumptions and theories on which those practices are based. The theories underlying TQM and traditional economic models of the firm are inherently incompatible.

Western managers have traditionally prided themselves on being pragmatic, eclectic, and open-minded, but the conflicts between these philosophies suggest that managers and their companies will increasingly need to choose between clinging to a single one size fits all approach vs learning throughout a whole employment, implicitly if not explicitly, to which school they belong.

There are a few examples of companies in which corporate restructuring and TQM have coexisted, but closer examination suggests that the approaches have been used sequentially rather than simultaneously.

TQM, as a vaguely defined quality management approach, was largely supplanted by registration to the ISO 9000 collection of standards and their formal certification (x) processes in the 1990s.

Business interest in quality improvement under the TQM name also faded as Jack Welch's success attracted attention to Six Sigma; a new fad, which claimed origins in Shewhart's statistical approach.

Toyota's success attracted attention to lean manufacturing. Though the three (TPS, Shewhart & Six Sigma) share many of the same tools, techniques, and significant portions of the same philosophy, they operate with a different focus on quality and implementation, and as such have different outcomes.

TQM lives on in various national quality awards around the globe.[9]

However, four new fads have emerged after interest in TQM waned; ISO-9000, Six Sigma, Lean Six Sigma and Agile. We aim to demonstrate that each of these is derived from ***Scientific Management Method*** and shares its disadvantages.

(x) with '*get the certificate for the reception area'* incorrectly seen as the objective.

2.2.2 QUALITY ASSURANCE / ISO9000

A BRIEF HISTORY OF QUALITY STANDARDS

TQM, as a vaguely defined quality management approach, was largely supplanted by registration to the ISO 9000 collection of standards and their formal certification processes in the 1990s.

In 1959 the United States developed Mil-Q-9858a *("Quality Program Requirements"),* their first quality standard for military procurement. It laid down what suppliers had to do to establish a quality assurance programme to assure compliance with the requirements of the contract. The quality procedures, processes and products shall be documented and be subject to review by the US Government. The QA programme shall ensure quality throughout all areas of contract performance including design, development, fabrication, inspection, maintenance etc., relevant to all forms of equipment, systems and sub-systems or services.

In 1968 NATO adopted the AQAP (Allied Quality Assurance Procedures) specifications – standards for the procurement of NATO equipment. At this time, suppliers were being assessed by any and all of their customers. It was widely recognised that this was very wasteful, duplicating effort and consuming resources unnecessarily. Quality control was left to the end user!

The development of quality standards reflected the desire to shift the burden of work from inspection by Government inspectors (secondary party inspection) to "quality assurance" guaranteed by the supplier through third party inspection. The idea was that suppliers should take responsibility for quality assurance and their methods should be assessed against generic standards of quality assurance. This was to open the door to third party inspection; it would lead to the establishment of assessing organisations.

In 1971 the British Standards Institute (BSI) published the first UK standard for quality assurance – BS 9000, which was developed for the electronics industry in response to the many problems that were occurring in this, another new industry. In 1974 BSI published BS 5179, "Guidelines for Quality Assurance".

The UK Government was also involved. During the 1970s, BSI orchestrated meetings of the many interested parties in order to agree a common British standard. The result was the publication of BS 5750 in 1979. Key industry bodies, that had developed contractual documents for suppliers, agreed to drop their own standards and reference BS 5750 instead. In keeping with the historical perspective, the purpose of BS 5750 was to provide a common contractual document, demonstrating that production was controlled. BS 5750 was, a method for the control of output. In response to the obvious problems we were having with our new technologies, this way of working was assumed to be a solution.

In 1982 the Department of Trade and Industry published a white paper entitled "*Standards, Quality and International Competitiveness*". The white paper also set out the arrangements for "*certification schemes*".

The Department of Trade and Industry funded "*road shows*" on the benefits of BS 5750 registration and provided funding to encourage organisations to use consultants in its implementation. This could be seen as a way of competing with Japanese companies practicing CWQ; perhaps, even, as an alternative to TQM.

BSI, with the backing of the UK Government, took the Standard to the international standards community.

It was the British Government's intention to have British standards earn respect in world markets. In 1987, BS 5750 and ISO 9000 became the same Standard. Quality assurance, according to the Standard, is a way of managing that prevents non-conformance and thus "*assures quality*". ISO 9000 is different from other standards: it is a management standard, not a product standard. It goes beyond product conformance, to how product is made, or service delivered.

The use of written documentation for each part of a worker's job, inherent in scientific management has obvious parallels to the documentation required for registration to the ISO 9000 series of quality standards.

Up to this point, quality was associated with conformance, rather than improvement; and quality assurance meant that conformance had been assured through inspection. It has become an end in itself, and has been promoted as a *'new and competitive approach to quality*', which it is not.

Experience shows that organisations have three reasons for seeking registration to ISO-9000 series;

1. Many organisations have sought registration as a result of pressure from their customers, or as a requirement for maintaining business.

2. Others believe that obtaining a Certificate and displaying it in their Reception area demonstrates that they are a "*quality organisation*". Sets the *absolute minimum* in requirements for a Quality Management System that can be independently audited.

3. A small minority seek to move towards the features and benefits of TQM, using registration to ISO 9000 as the foundation. While this is possible, it requires considerable effort and dedication. There is little evidence that organisations achieving registration to the Standard have improved their performance significantly. However, it could be seen as a first step in the journey to best practice. All-in-all though, even though mentioned in the standard, this is not PDCA.

Juran says that Scientific Management has profoundly influenced our management of the quality function, as exemplified by ISO 9000.

It provided a strong impulse in the movement to separate inspection from production, i.e., to use full-time inspectors for product inspection and process control rather than to rely on the workmen.

The evolution of quality specialists (quality control engineers, reliability engineers) was again an extension of the concept of separation of planning from execution.

The proliferation of Taylor's piece work systems was a strong influence in the decisions to create independent inspection departments to take over the command of inspectors (who had previously been under the command of production foremen).

2.3 SIX SIGMA

And then in the late 1980s, a new methodology, that of Six Sigma was introduced.

Because of the term Six Sigma, it is generally thought that this methodology is based on the statistical methods of Shewhart and the quality improvement ideas of Deming, later used by Japanese companies under the practice generally known as Total Quality Management (TQM). Later incorporated in the Toyota Production System (TPS). This sounds plausible but is not the case.

Six Sigma is a method that is claimed to provide organisations with the tools to improve the capability of their business processes. It claims to be a project-oriented approach for removing defects, and eliminating waste from products, processes, and transactions. Organisations seek to reduce defects and achieve Six Sigma quality; defined as 3.4 defects per million opportunities (DPMO).

Six Sigma also claims to be about improving profitability. According to Mikel Harry [10], companies implement it with the goal of improving their margins. In the "*Themes of Six Sigma*" he says it allows organisations to drastically improve their bottom line by minimising waste, errors, and resources. It is claimed to drastically improve financial results, in other words, better profitability.

Indeed, these two concepts are diametrically opposed. Six Sigma is based on Acceptability, whilst Shewhart's methodologies are firmly based in Desirability. See Appendix 3.

Scientific Management permeates Six Sigma, and two related concepts.

Six Sigma originated in Motorola, who were being battered by Japanese competition in the 1980s. Motorola already were a respected manufacturing firm and had stringent quality measures. However, their analysis had revealed that they were lagging way behind the Japanese (xi) and to be competitive they had to improve their quality goals by a 1,000% in five years. An initial goal of a 10:1 quality improvement was set out.

Motorola management summoned their top engineers and told them to combine all the best quality management practises known till that time and make an aggregated methodology which would be the base of Motorola's competitive quality improvement program. An internal methodology became a company-wide initiative. In 1985 that became known as Six Sigma.

By reference to misunderstandings of the statistical work of Shewhart and Deming, they defined Six Sigma quality as a target that the organisation should seek to achieve just 3.4 defects per million steps, insisting that 99.99966% of its products or services are without flaws.

"Originally Six Sigma was developed by Motorola to achieve Six Sigma levels of quality. This was further developed by Allied Signal and GE into projects managed by Black Belts in a cost-reduction program—every project needs a clear ROI. In other words, the program went from a leadership philosophy, i.e. built-in improvement, to a bunch of one-off projects to cut costs, i.e. bolt-on quality (xii).

(xi) The Japanese had been concentrating on product quality and the manufacturing processes, not growth and profitability.

(xii) But quality is not a cost, it is an enabler / productivity moves up as quality improves

ELEMENTS OF SIX SIGMA

Six Sigma is an extremely vague concept. Don Wheeler [11] described Six Sigma as *"a blend of tortured computations and incompatible, highly questionable assumptions having a hypnotic effect, often resulting in a suspension of critical thinking".*

It is claimed there is a direct correlation between reaching higher sigma levels and cost of poor quality a shown in following table 1:

SIGMA LEVEL	DMPO	Cost of Quality
2	308,537 (non-competitive)	N/A
3	66,810	25 – 40% of sales
4	6,210 (industry average)	15 – 25% of sales
5	233	5 – 15% of sales
6	3.4 (world class)	<1% of sales

Table 1 from: S. N. Teli, Dr. V. S. Majali, Dr. U. M. Bhushi, Sanjay, 2012, *Automotive Product Development Process (APDP) Strategy by Integrating Six Sigma to Reduce the Cost of Quality.* Journal of Mechanical and Civil Engineering Volume 4, Issue 3, Table VIII

This is achieved by improving quality, defined as the value entitlement of both customer and provider, in every aspect of their business relationship.

Harry proposes an eight step "breakthrough strategy" to implement six sigma; Recognise, **D**efine, **M**easure, **A**nalyse, **I**mprove, **C**ontrol, Standardise and Integrate **(DMAIC)**. This is clearly based on Deming's **PDCA** Cycle, but is actually a project management methodology.

Six Sigma is project driven being implemented by champions and black belts who control it and other belts who carry it out. Each project must have a defined contribution to the bottom line - before it is approved.

Deployment of Six Sigma

Regardless of the deployment strategy employed, there are three features of every Six Sigma, (Lean, Six Sigma, or Agile) project implementation: Top management; visible support; Use of an expensively trained cadre of elite practitioners – "Belts" who implement the projects; and Projects must demonstrate a positive RoI before they are approved.

Six Sigma deployment is a project-oriented approach. Six Sigma projects are typically 4–6 months in duration and are selected for their potential impact on the business.

A project should represent a potential breakthrough in the sense that it could result in a major improvement in the product or service. Project impact should be evaluated in terms of its financial benefit to the business, as measured and evaluated by the finance or accounting unit. Obviously, projects with high potential impact are most desirable. This financial systems integration is standard practice in Six Sigma. The value opportunity of projects must be clearly identified, and projects must be well aligned with corporate business objectives at all levels.

CONCERNS ABOUT SIX SIGMA

According to Hopper and Hopper [12]; *"Six Sigma at GE was a major and long-lasting public relations campaign to enhance the reputation of CEO Jack Welch and drive up its share price. Credentialism ruled, those members of staff who taught or applied Six Sigma were awarded a fancy Belt. People who knew nothing about a Division would descend on it, allegedly to enhance performance, but in fact to engage in financial cosmetics. …. this was enhanced by the sound of institutional investors encouraging them to work backwards from a projected rate of return on capital."* Six Sigma was the pre-eminent management credential.

They say that as Taylorism has morphed into neo-Taylorism in the last 50 years, the so-called staff experts in neo-Taylorism are claimed to have five attributes:

1. Financial Goal Orientation.

There is one quantitative approach that seems to give an insight to every part of the organisation – the accounts! Every Six Sigma project must have a financial rationale - a defined RoI in advance.

2. Credentialism – a plethora of paper qualifications *("coloured belts")*.

The cadre of "*belts*" in Six Sigma constitute elite staff groups who alone can control the project methodology. A separation of investigation, analysis, and planning from doing. Harry says that a six sigma project must be strongly tied to compensation; "champions" and "belts" should be compensated for their efforts, suggesting that 30% of their income should be tied to six sigma success. It is well known that such incentives do not work.

3. A top-down method of working, (Champion→MBB→BB→GB).

The underlying belief is that scientific management provides the basis for separating management from the execution of work. 'The rationalisation of work has the effect of transferring functions of planning, allocation and co-ordination to managers, whilst reinforcing the managerial monopoly of decision-making, motivation and control'. Hales (1994) [13].

4. Unclear definitions.

The concept of "defect" is unclear, six sigma is a muddled concept and the claimed financial benefits of increased sigma levels remains as an unproven assertion.

5 Basic problem-solving expertise could be transferred to any situation.

To solve actual problems, it takes more than one method, one observation, one study or one experiment. To demonstrate improvement, one must wait to see the process developing and confirm the results based on verification of the "*fix*." Storytelling alone won't do it. We need to invest a great deal of thought and set achievable measurables on a good objective to track the improvement. Hopper and Hopper say that Six Sigma includes the discredited concept of the professional manager; "*an expert who need know nothing of the domains in which he operates and who can sort out problems because he has been trained to sort out problems*".

Is it Scientific?

It is NOT based on the scientific approach. Six Sigma uses bog standard statistics, project and process management techniques in a nicely packaged, well promoted marketing proposal.

By focusing on operating tolerances, Six Sigma dismisses Genichi Taguchi's loss function [14], which targets uniformity around a nominal with no references to specifications. Indeed, Six Sigma takes us backward.

Moreover, from Taguchi and Clausing [15] (see pp82, on robust design and loss function in quality), it is most important not to design or manufacture just to specification. A methodology that gained the label of "*Zero Defects*". Simply eliminating variation, i.e. pursing zero defects in manufacturing (applies equally to service sector operations), will not guarantee zero failures of your product or service in the field. What management needs to drive, and all attend to, is to reduce product (physical or service) failure in the field. And this will drive fewer defects at source. In summary, fewer field defects drives fewer source defects resulting in lower costs. Concentrating on only reducing defects at source (xiii) does not drive fewer defects in the field.

A drive for Zero Defects is in effect a Taylorist approach. Do the minimum to meet tolerance limits, all else is cost. But as Taguchi shows, and Japanese manufacturers found (as expanded in Appendix 3), higher quality leads to lower costs.

Does it Work?

After twenty-five years of Six Sigma, there is no evidence of any lasting success. Only an endless parade of hollow promises, followed by failure after failure. Claims that companies saved billions and billions of dollars, year after year, are unsubstantiated. [16]

Evidence from four leading organisation suggests that Six Sigma was implemented, in part at least under the influence of investors interested in return on equity, return on invested capital and stock price, who saw Six Sigma as a Badge of Approval and Respectability, adding a patina of scientific management to the hum-drum financialised projects of cost-cutting, head count reduction, and outsourcing. It also camouflaged these projects as quality initiatives.

If anything, Six Sigma focusses on efficiency. But, a better place to start is by asking the question, ***"Is this going to be effective in delivering the service to the customer?"*** Evidence from some of the example organisations suggests that the need for Six Sigma Projects to demonstrate a positive RoI (RoNA) to be approved, by others, stifled innovation and inventive engineering, with negative consequences for their overall performance and the consequential loss of benefit to the organisation.

(xiii) And Six Sigma focusses on fixing problems at source (a capability of 2), a Zero Defects approach. But this does not guarantee fewer failures in the field as being within specification is not a sufficient position. What is needed is to concentrate on reducing failures in the field, as this will both drive better customer satisfaction, and ensure there is less spread from target at source. By spread, we mean on target with minimal variation. That is, as far inside specification as is needed to ensure there are no failures of the completed item, assembled product or delivered service. Whilst Six Sigma is aimed at a capability of 2, the Taguchi approach is aimed at capabilities of 3 to 5.

So why did it become the "go-to" Fad

Six Sigma captured the imagination of CEOs around the world. It offered high levels of net profitability by reducing "errors", no management transformation or culture change was required.

It required little upper management involvement in day to day activities of Six Sigma project teams.

- Six Sigma's message that no management transformation or culture change is required.
- When Six Sigma projects are said to result in real savings, upper management pays attention.
- Six Sigma is attractive to stockholders, top executives, members of the board of directors, and business analysts who guide investors because they typically are interested in return on equity, return on invested capital, stock price, dividends, earnings, earnings per share of stock, growth in operating income, which Six Sigma is said to augment.
- Business leaders are more likely to be fully supportive, to commit the resources needed to train personnel, and to make Six Sigma positions full-time, using these positions as steppingstones to higher positions of responsibility in the organisation. In other words, set up a separate quality function using the Training Budget as a resource!
- Six Sigma became a Badge of Approval and Respectability for organisations. It added a patina of scientific management to the hum-drum financialised projects of cost-cutting, head count reduction, outsourcing, down-sizing, to name a few.

Six Sigma was a classic management fad, Abrahamson [17] says, *"promoted by highly regarded companies like Motorola and GE, as a result, it spread widely. The Six Sigma rigor of generating metrics with baseless success measures and the implementation of specialised statistical tools that measures things for no reason except to measure things, using principles, techniques, and concepts that create reports that no one wanted, needed, understood, or read; and financially driven projects, squashed ingenuity and stifled innovation."*

Six Sigma is a marketing dream that has mesmerised many quality professionals for at least two reasons.

First, because both the training and qualification are controlled as though the concepts are unique and innovative and can only be understood, taught, and implemented in one way.

Second, Six Sigma sounds impressive because some major corporations claim exceptional returns on their Six Sigma investments. Six sigma does indeed have an attractive message for CEO's – do this and you will save millions on the bottom line!!.

2.4 LEAN

There are two distinct methodologies which are described as "Lean". A version we chose to call "Lean manufacturing", loosely based on the original work of Jones and Womack, which morphed into Lean Six Sigma. A second method based on TPS, and promoted by people with deep knowledge of TPS, which we will refer to as "Lean" from now on.

ORIGINS OF LEAN

In 1913, Henry Ford introduced the assembly line, an entire production process at Highland Park, MI, to manufacture his Model T automobile. Mass production combined interchangeable parts with standard work and a moving track. The problem with Ford's system was the inability to provide variety. The Model T was not only limited to one colour - black. It was also limited to one specification; while different bodies were offered, the basic chassis was unchanged from 1908 until 1927.

As we noted in 2.1, Kiichiro Toyoda, Taiichi Ohno, and others at Toyota visited Detroit between the Wars, and just after World War II. It occurred to them that a series of simple innovations might make it more possible to provide both continuity in process flow and a wide variety in product offerings. They re-thought Ford's original thinking and developed the Toyota Production System (TPS). The TPS was primarily based on three values: Flow, Continuous Improvement, and a Respect for both customers and employees.

We also noted in 2.1.1 that the application of these methods had significant, and undeniable, results; dramatic increases in Japanese product quality and productivity. This production system was so effective that it is one of the reasons that Toyota has grown to be, and to remains one of the leaders in the global automobile market.

This did not go un-noticed in the USA; the International Motor Vehicle Program (now known as PVMI), founded at the Massachusetts Institute of Technology in 1979, has mapped lean methodologies, established benchmarking standards, and probed the automotive value chain. Its data-driven methods set the standard for industry research. More than 50 senior scientists, management experts, social scientists, and engineers have conducted interdisciplinary automotive research at more than 25 universities on six continents.

The program has gone through several phases, the one that concerns us is Phase One (1979–1990). During this first phase, IMVP is best known for developing the name "lean production" to characterise the new paradigm that challenged mass production starting in the 1970s and 1980s. Two important books came out of this Phase;

Cusumano 1985 [18] was probably the first article to track the development of the Japanese automobile industry.

Krafcik 1988 [19] was the first who coined the terms "buffered" to describe the recent Fordist car plants who were buffered against almost every risk, and "lean" where everything is minimised to maximise productivity and quality. He showed that lean manufacturing plants have higher levels of productivity/quality than non-Lean, and that the level of plant technology seems to have little effect on operating performance".

Risks with implementing lean are reduced by developing a well-trained, flexible workforce, product designs that are easy to build with high quality, and a supportive, high-performance supplier network. From the initial Phase of the International Motor Vehicle Program, Womack and Jones [20] (1990 and 1996) used the term "lean thinking" to capture the essence of their in-depth study of the Toyota Production System (TPS).

The lean model is not an install and leave alone with little senior management intervention. But no effective management model ever was. Lean demands, rightly and properly, the involvement of senior management if it is to be effective.

No question, by the end of the 1980s the world was well aware of the nature of lean production and lean thinking.

THE ELEMENTS OF LEAN

The Shingijutsu Consultancy [21] defined a primary structure that employed a series of steps that emanated from four key principles:

1. **Always Maintain a Long-Term Vision**: Base your management decisions on a long-term vision, even at the expense of short-term financial goals.
2. **The Right Process Will Produce the Right Results**: Work processes are redesigned to eliminate waste (muda) through the process of continuous improvement (kaizen).
3. **Add Value to the Organisation by Developing Your People**: Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.
4. **Continuously Solving Root Problems Drives Organisational Learning** Go and see for yourself to thoroughly understand the situation.

Jones, Womack and Roos [22] defined the elements of lean as;

1. Define Value

Value is what the customer is willing to pay for. It is therefore necessary to define the actual or latent needs of the customer. These are defined along the customer's experience of the product or service. This in turn is translated into the design specification of the product or service, namely (QFD) Quality Flow Deployment.

2. Map the Value Stream

Using the customer's value as a reference point, identify all the activities that contribute to these values. Activities that do not add value to the end customer are considered waste organisations can improve effectiveness.

3. Create Flow

After removing the wastes from the value stream, the following action is to ensure that the flow of the remaining steps run smoothly without interruptions or delays.

Some strategies for ensuring that value-adding activities flow smoothly include: breaking down steps, reconfiguring the production steps, levelling out the workload, creating cross-functional departments (xiv), and training employees to be multi-skilled and adaptive.

(xiv) not to be confused with cross functional or matrix management which has no place in this methodology.

4. Establish Pull

The goal of a pull-based system is to limit inventory and Work in Process (WIP) items while ensuring that the requisite materials and information are available for a smooth flow of work. This ensures that the products produced will be able to satisfy the needs of customers.

5. Pursue Perfection

This is the most important step. It makes lean thinking and continuous process improvement a part of the organisational culture. Every employee takes part in improvement activities while delivering products based on the customer needs. The company should be a learning organisation and always find ways to get a little better each and every day. At Toyota, there exists a way to solve problems that generates knowledge and helps people doing the work learn how to learn.

LEAN IN ACTION

At a Toyota plant, this translates into action through a set of practices which create an environment for learning:

1. **Kaizen activities:** in other words, improvement – which is a normal part of everyone's job, following Deming's plan–do–check–act model.
2. **Kanban:** the foundational practice of lean thinking it is a visual method to manage workflow against customer demand.
3. **Autonomation:** otherwise Jidoka, which enables automatic equipment to stop when a problem is detected.
4. **Andon:** enables line workers to halt the line and, automatically, signal on a central board so that help can come quickly.
5. **SMED:** Originally known as single-minute exchange of die (changing tools under 10 minutes), SMED is a key lean thinking practice to focus directly on flexibility.
6. **Standardised work:** in a standard Lean implementation, Standardised Work may be described as follows: documentation of the sequence and process for each operation. The objective is to clearly communicate to the operator exactly how the job should go. It teaches lean thinking by visualising every obstacle to smooth working and highlighting topics for kaizen. But in a true Standardised Work philosophy, it has more to do with engaging people in the design and operation of their environment. See below:
7. **Visual management:** uses instinctive visual cues to make succinct, accurate information within a workplace available at all times to those who need to know it. Teaches lean thinking by getting people to work together on their own problems and develop their responsibility to reaching objectives without overburden.

STANDARDISED WORK

Section 1.8 on TWI described the development of a production system that was used to great effect by the USA in the early 1940s and which was taught to the Japanese in the early 1950s. the Japanese took the TWI programme and the teachings of Deming on statistics, worked with them, and then added to them.

A core element behind the methods and teaching was improvement. The process of proofing the business activities against design, manufacturing and assembly defects. One aspect of changing a process that some Japanese companies studied was that of drift or decay of a transformed method (way of doing things). What they realised was that if the new method, once proved to work and to actually be an improvement, was not consolidated, then the new method would over time drift away from the new ideal and become sub-optimal.

To counter this, the concept of standardised work was developed. Standardised Work is not just simply documentation; it encompasses all the elements of the way things are done, the way activity stations are laid out, how people fit into and are involved with the work at those stations. Down to the input of the people in the design and operation of their work-cell It is about the way a person integrates with the activities. By this process, the new method becomes embedded in the standard activity by which it becomes the foundation for the next improvement.

A core element is that all people in the organisation need to learn how to solve problems to the immediate benefit of the organisation, but for the long-term objective of ensuring that the customer is supplied with a defect free product.

There are many ways of diagrammatically describing this; the one reproduced by Hall [23] is given here in fig 4.

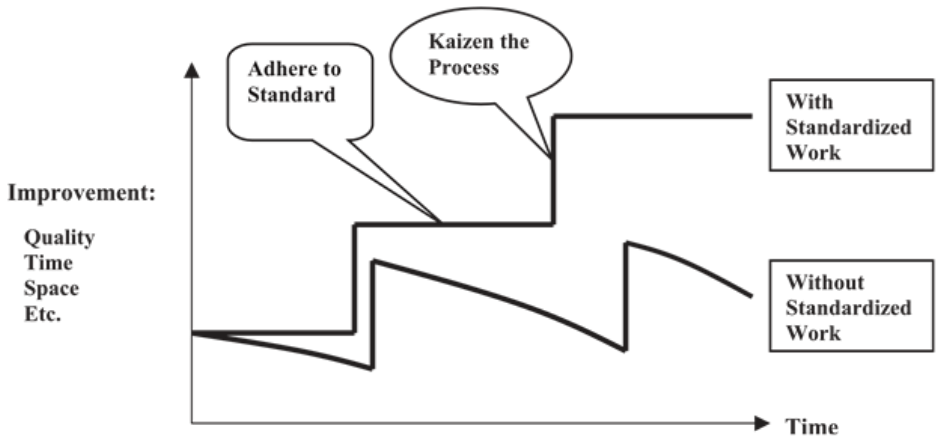


Fig 4: The relationship between Standardised Work and Improvement. From Hall [23]

Improvement made as a series of small steps that build on successive gains is more easily controlled, easier for people in the organisation to deal with, both managerially and practically, and it leads to a stable organisation. Small incremental steps are also easier to deal with if the change made was not totally successful; they can be more easily reversed. Whereas big changes are always fraught with difficulties and consequential effects at multiple levels. The small step approach delivers sustainable improvement that is easier to manage.

And Standardised Work is not simply a procedure to be followed, it is the entire improvement process. And he most important element in this process is the people. This process embeds the workflow design, the work area and the control with those doing the work. A full integration of the roles of design, planning and doing with the people at the place of doing; a complete antithesis to the teachings of Taylor. The way many current workplaces are designed and managed leads to a strangulation of workplace and process redesign that resists the legitimacy of external signals for change.

DOES IT WORK?

In the early 1990s, Boeing — facing a deregulated commercial airline industry that had begun to focus on profitability — realised it needed to become leaner in order to offer its customers airplanes at reduced costs and improved quality. Company executives travelled to Japan, where they studied concepts that would become known as Lean — just-in-time delivery, error-free production, and continuous flow. Boeing brought in consultants from Shingijutsu Co. to help guide the process, [24].

In 1987, Shingijutsu was formed in Nagoya, Japan. The founder, Yoshiki Iwata, was an original member of the Toyota Autonomous Study Group (a project team comprised of Toyota's suppliers). Shingijutsu promoted this Kaizen system throughout the world, providing consulting to world-class companies including Boeing. Shingijutsu's representatives were former Toyota executives and proteges of Ohno's Toyota Production System. They were firm believers that employee empowerment and buy-in are pillars of Lean.

"*To make planes is to make and develop people*", said Chihiro Nakao, the Shingijutsu founding consultant respectfully referred to as "Sensei," or "Teacher," by his Boeing clients. "*We use the word 'kaizen' (continuous improvement), but all it's really about is training the people who make it happen.*"

Boeing's mid-1990s shift to Lean is already reaping tangible dividends. Consider: The 757 program's field processes have transferred to Final Assembly, saving one day of flow time. Also, Systems Installation has moved into Final Assembly, housing all assembly and integration processes under one roof.

And, by 2000, the 737 program has shaved its flow time by 30 percent, reduced its crane moves by 39 percent, lowered its inventory levels by 42 percent, and reduced its needed floor space by 216,000 square feet (over 20,000 M^2).

PROS AND CONS OF LEAN

There is no question that "lean" works when applied to traditional mass production arrangements. There is a large body of evidence to show that lean production can provide substantial increases in productivity, quality and flexibility.

But, as Cusumano and Krafcik explain, "lean production" is a high-risk strategy; without buffering, problems can escalate quickly, which is why traditional "batch and queue" mass production has high levels of supplier, intermediate and end-of-line inventories, armies of utility workers, etc. to prevent the line stopping.

However, these mitigating countermeasures of lean require a considerable change in production methods and to the culture of the organisation. They conclude that in circumstances where mass production of a single product with a viable customer base, the risks associated with "lean" may not be justified.

"Lean", uses a variety of tools to maintain smooth flow to the customer and mitigate these risks with an empowered, well trained, flexible and experienced work force, responsive suppliers and robust product design for manufacture.

In attempting to broaden the applicability of "lean" to other areas such as the service sector, many commentators and advisors have attempted to widen this tight knit set into a loose framework reflecting the difficulty in translating the tightly knit set to a format understandable by people in the service sector.

2.5 LEAN SIX SIGMA

Various business and manufacturing paradigms and methodologies have evolved over the years to help an organisation realise their goals. Two of the most influential (although not for the same reasons) are Lean methodologies and the Six Sigma philosophy of management. In the early years of the second millennium some commentators and consultants saw a market opportunity in combining Lean and Six Sigma. The idea was said to provide the best of both these concepts. Lean principles were said to help to reduce or eliminate process wastes, while Six Sigma was claimed to focus on reduction in defects to improve the efficiency and quality of the process.

It claims to be a fact-based, data-driven philosophy of improvement that values defect prevention over defect detection. It is said to drive customer satisfaction and bottom-line results by reducing variation, waste, and cycle time, while promoting the use of work standardisation and flow, thereby creating a competitive advantage.

It is worth pointing out that there are two versions of 'Lean', as outlined by Hall (2004). Firstly, a concept based on observation of the Toyota Production System (TPS), as outlined in Sections 2.1 / 2.3 & 2.4. Second a methodology that Hall describes as "Lean manufacturing", a descendent of TPS made popular by the Lean Manufacturing Institute. [25]

Lean manufacturing is a project-based method; projects are likely to start with overall process flow chart called Value Stream Map, a term attractive to the dollar minded. Guided by Value Stream Maps, overall goals are quantified as indicators for a "dashboard" to track progress toward the vision.

Lean manufacturing projects tend to be more "engineered" by staff than TPS, that turn Value Stream Maps into the key process measures and blitz processes with kaizen events. Kaizen teams may pounce on some fat targets first, but to integrate the effort, they usually start at final assembly and work back, setting up work to flow, as in a cell. Staff and management almost always direct a lean conversion. Usually, a consultant more experienced in the journey guides them at first.

Lean is said to use less technical tools such as kaizen, workplace organisation, and visual controls, whereas Six Sigma tends to use statistical data analysis, design of experiments, and hypothesis testing.

Often implementations begin with the lean approach, making the workplace as efficient and effective as possible, reducing waste, and using value stream maps to improve understanding and throughput.

However, these two approaches are not in the same mould. Lean has at its core a continual improvement methodology with roots in Taguchi and a *desirable* (see appendix 3) mindset.

Whilst Lean manufacturing is a project-driven methodology focused on cost reduction, implemented by staff / management with no focus on developing people in problem solving and improvement.

The biggest differences relate to how TPS, much more than lean manufacturing, emphasises respect for people, hence developing their ability to identify and resolve basic process problems.

ORIGINS OF LEAN SIGMA

Two books by George [26] and Wheat, Mills and Carnell [27] are thought to be the first to define this new management paradigm (fad) combining the two methodologies of Lean and Six Sigma. Of the two, the book by George presents a more comprehensive account of Lean Six Sigma. It is claimed to be the first book to provide a step-by-step roadmap for profiting from the best elements of Lean and Six Sigma.

Here, the ultimate goal of a business is to provide benefits to its shareholders. To do this, they have to assure the highest quality in their products and ensure optimal and efficient management of processes. George explains how this can be achieved by implementing Lean Six Sigma practices across every area and every process of an organisation.

He explains in detail a management paradigm that is claimed to combine the best features of both the Lean principles and Six Sigma practices, in order to achieve maximum efficiency and highest quality. It claims to demonstrate how to cut time and cost reduction, minimize order to delivery time, and also significantly reduce deviation from quality specifications throughout the organisation.

It first explains how to combine the two methodologies to derive the highest benefits for the business.

It then shows how to implement Lean Six Sigma tools and methods across the organisation

By providing insights into the application of 'Lean Six Sigma' to both the manufacturing processes and the service and transactional processes, it promises to revolutionise the performance efficiencies in virtually every area of your organisation as it positively and dramatically impacts your shareholder value.

Lean Six Sigma is claimed to;

Increase capacity

Improve efficiency

Minimise costs

Maximise profits

Increase Shareholder value

Strengthen customer focus

Reduce errors by solving problems at root

Although it is difficult to find consistent evidence of these benefits.

If process problems remain, more technical Six Sigma statistical style tools may then be applied. There exist, of course, expensive Lean Six Sigma Black Belt training courses.

Concerns about Lean Six Sigma

Lean Six Sigma suffers from two major drawbacks

It suffers from all the problems we have noted for Six Sigma; Multiple "Belts", top down methods of working, project focus with a financial goal orientation, etc., etc.

Given this it is difficult to see how lean principles can be combined with those of Six Sigma. For example, it is difficult to square the zero-defect mentality of Six Sigma with the Taguchi loss function and robust design.

Lean on its own however is a robust and practical technique that is at the core of effective systems such as the TPS. It was explored in more detail in 2.4.

The further concern is that Lean based on TPS and its principles, whilst at odds with Six Sigma, are subsumed into a mixed mode where the full benefits of a lean only approach cannot be fully realised.

Simply, Lean based on TPS is separate from Six Sigma. The two are at the fundamental level incompatible paths, of which lean was a derivative of TWI and is foundational to eastern operational models.

2.6 AGILE

The concept of Agile was developed in the software industry where it found success. Later it was seen as *so good* that it ought to be a structure for how all management activities should operate. And indeed, it has become a buzz word for many organisations to describe the way they set about the digitisation of their services. But digitisation is not a guarantee of *fitness for purpose*. We see three stages in the growth of Agile:

1. traditional and as originally perceived in 2001

2. a metaphor for a series of activities within a traditionally structured organisation. In this context, the main issue for agile (as originally perceived) falling by the way side, is that organisations have tried to implement an Agile program in what is basically, a command and control organisation.

3. a label, along with Lean to represent what is a wholesale, and in our eyes, overdue change in the way organisations and the people within them operate and collaborate. Almost, more about adaptive and self-managing organisations which exhibit respect for the members of the organisation throughout all activities.

How did Agile start?

Agile began life in 2001 [28], when 17 software developers, frustrated at the frequent failure of large IT initiatives, met to seek a more proactive and interactive way of developing software that would on completion be more closely integrated to customer need by working closely with customers during the development phase. They argued a need to move from traditional (waterfall) to collaborative sequential (short burst) writing methodologies. And the addressing of culture and values in organisations (xv).

The key idea was to develop applications alongside the people who use them [which is not always the Customer, but the Consumer (xvi) auth.], in short spurts for rapid delivery. The ambition was and remains largely sound.

(xv) The overarching problems of *culture* and *value* being discussed were really about wider systemic problems in organisations dubbed as Dilbertesque. Basically, Command and Control management with its roots in the methodologies expounded by F. W. Taylor. But as we shall see, Agile as a hijacked management concept, needs to utilise high levels of Command and Control to manage the compound mini projects that comprise a development.

(xvi) due to the very nature of the roles in these applications we need to differentiate between the Customer and the Consumer. We use Consumer to separate the end user of a service or product as being distinct from the Customer who buys the software development from the developer, and who deploys the application to the Consumer. And it is the way the Consumer interacts with the application that needs careful consideration by both the Customer and the Developer. It is reported, that all too often the development is based on a thought up consumer persona and not what a real consumer wants. Akin to having a cardboard cut-out of a consumer in a physical board or other internal meeting. Oh yes, it does happen! There is no workable alternative to going and finding out what is needed from the consumer themselves.

For some organisations, the Agile approach to software development has reaped benefits. Development times are shortened and the end product is more applicable to the need. Often, for these organisations, they are organised and managed in an adaptive way.

But for many organisations, unseen difficulties arose after the Agile concept, devised specifically for IT development, was erroneously hijacked as a universal solution to the digitisation of services and other management activities.

What Agile commonly morphs into

Agile's step from a methodology for software development to an enterprise wide project management tool was precipitated in an article by Rigby, Sutherland, and Takeuchi [29].

In these situations, Agile is reportedly showing large-scale failure rates for IT solution-based improvement (digitisation), as anything between 30 and 60%. And in order to control the activities of the *'Agile'* programme, large amounts of command and control management are inappropriately and unnecessarily applied. By which, a new and basically sensible approach to IT deployment is hijacked into old style Taylorism management. A perusal of Agile offerings reveals similar roles (Scrum master, product owners, agile mentors etc.) with training programmes akin to Six Sigma. And both Agile and Scrum are team focused rather than product (customer / consumer) focused.

One needs to start where you currently are; as you cannot move on until you understand the current position which has to include how both the customer and the consumers of an application are catered for. Managers, and their teams, need to resist the urge to take the "*obvious and easy solution*". And Managers need to rationally analyse the current position, proposed solutions and most importantly, actual consumer need (whether expounded or not) before proceeding with a solution. [30]

By way of an example; a commonly reported problem in digitising services, is that the solution on offer is by design comprised of necessarily bounded packages that are perceived by those responsible for their structure to be the whole range of solutions to all consumer problems. Or indeed, simply a way of automating something with the purpose of reducing head count.

By definition, the packages need to be contractually controllable and built as chargeable chunks of service. So, the digitisation project produces Blue Square / Green Triangle / Red Round thing problem solutions for delivery to consumers. But the *root-cause-problem* is that most consumers turn up with say Orange Oval type problems. As such, the service provider cannot solve the problem of the consumer and that results in large amounts of failure demand and associated cost backing up in the organisation and frustration for the Consumer.

Those commissioning and those developing the digital solutions are often unaware of the consumer issues at the consumer / organisation interface. Indeed, it is reported that anything about that interface is not usually built into the reporting model. The performance indicators they see are based on such as, time to answer the phone [in a call centre], the number of pre-packaged interventions delivered, the 'first time fix' metrics, which may not fix the actual consumer problem at all, and say deployment time. And these indicators do not report on the effectiveness of the intervention from the consumers perspective. The service delivery indicators are simply reporting metrics associated with matters unrelated to the consumer. And the underlying problem stems from Managers in the Service Company not being fully aware of matters arising at the actual consumer / organisation interface or being familiar with and understanding the blockages that confront the consumers dealing with their digitised services.

All this leads to something called Failure Demand. That is, the demand in work load placed on the organisation, that is purely down to the failure of the organisation to solve a consumer's problem, and as such, the problem comes around again and has to be dealt with again. Issues such as these, tend not to be reported the either. A situation that represents rather an own goal. Seddon [31] reports that in some organisations, the Failure Demand can vary between 40% to 70%, but in others it can be as high as 90%.

A commonly used phrase in Agile development is that '*an organisation aspires to…*', but where in the aspirations is the consumer? The authors see little mention of consumer in agile programme outlines or descriptions. No mention of what the consumer needs, or how the agile offering will align with those needs.

There appears a desire for digitisation, before and separate from the consumer's needs as expressed at the consumer interface.

Simply:

Digitisation needs to follow good system design, not precede it.

And the order has to be:

Purpose Process How (technology)

But what is all too common is a rush into a technological solution preceding good system design. Or even, consideration of how an end user might cope with an implemented embodiment of the organisation's perception of how these things should be done, rather than, to be effective, what needs to be done for the end user.

This all feels like time to development and deployment being of the essence. There is a well-worn phrase from the latter half of the last century which goes: *"when the new production machine arrives all our production problems will be solved."* This was often said by senior managers unaware of and generally not searching for the current capability of their equipment. (xvii) A mantra akin to '*when this process is digitised it will…*' when in practice, an in-depth study of what needs to be in place (including scope of offering, deployment to the consumer with feedback, and interface) for the offering to be effective for the consumer and their needs should proceed any system design, fabrication of solution and implementation, regardless of the proposed solution methodology or system of build [32].

Before you can effectively start to change a working operation, i.e. say, digitising the customer interface to the organisation, you need to both know and study the actual operation of a number of things:

- How it is working now? What actually goes on when a consumer makes contact with the organisation? How are their requests interpreted and handled, and how is the consumer connected with the right people who can deal with their problem?
- If it is a complaint, how is the consumer going to be guided through the often-perplexing maze to get a resolution? How does the system avoid serially passing the consumer from dead end to dead end? Which is all too common in digitized systems.
- What does your interface system have to do to achieve that? How does it interpret the consumer need? How does it ensure that the consumer's real need is dealt with, as opposed to their expressed want?
- How does the consumer interface system navigate the organisations internal systems to deliver the service? After all, people at the consumer interface know a lot more about how the organisation works internally. The consumer rarely knows.
- How is the end outcome from the consumer's perspective garnered and understood? And essential element in their organisations learning and development.
- Above all, who owns the consumer problem if the system cannot currently respond effectively to the consumer?

Organisations need to resist the often-expressed managerial imperative to bring this to an early conclusion; which necessitates taking what appear to be obvious or easy steps. Once committed, businesses are very reluctant to go back and alter something, even when what was built in the first place is not effective at all.

(xvii) visitors to Japanese plants often comment that the levels of automation and technology are lower than in their own plants; yet the output and quality levels are much higher and the equipment more flexible. And many plant managers often seek a capital solution to a day-to-day revenue issue. That is, finding out the actual capability of their plant.

All the above needs to be analysed rationally before jumping into the digitisation process. Indeed, it needs to be fully understood and analysed anyway before a change is made, but doubly so for digitisation developments.

Table 2, below, is a comparison of the objectives from the Agile manifesto the activities described in a typical Agile implementation.

What is Agile?	
Activities	**Objectives for change**
• Extreme programming • Pair programming • Sprints • Burn-down charts • Backlogs • Continuous integration • Planning poker • Refactoring • Retrospectives • User stories • Velocity • Timeboxing • Kanban boards	• Values and Principles • A culture and commitment to continual communication • A desire to validate rapidly a result to ensure a good understanding of the client's needs • An ongoing, predictable delivery of value to the client and end-user • Self-discipline based on self-organisation of an empowered team • Continuous improvement

Table 2: A comparison based on The Agile Manifesto Principles and working practice. From a presentation by P Leeson; *Agile Does Not Solve IT* [33]

Whilst the objectives constitute a sound and worthy ambition, with echoes of a lean culture, the list of activities on the left (often referred to as *'Ceremonies'* – which they are not) resemble more a hard project management approach with high levels of command and control with a cost focus.

There is no doubt that in the broader sense Agile has a catchy title which is evocative of fast reaction, swift resolution to arising issues allied to a drive for staff reduction, in itself coupled to consumer digital interfaces has high appeal. But there is little point in digitising something if, when it is used by the consumer, it does not properly work, has an impediment interface, and does not solve the consumers need. Even more frustrating, is when it simply fails to complete on say a transaction, and the *'Help Line'* is less than that.

Sound developments are built on a purpose allied to actual customer need, followed by *slow deliberation,* and then by *fast deployment*. The 17 software engineers that met at Snowbird in Utah in early 2001 were right. The issue is; that the slow deliberation, the sorting out of what has to be put in place for the consumer to get their problems solved; is at best poorly thought through and often, missing.

Agile in a New World

There is little doubt that at the time of writing this paper, the phrase Agile, has in some quarters become a buzz word that many organisations use to describe what are in reality a series of '*bolt-on'* changes in style to an otherwise traditionally structured and controlled organisation. But Agile was originally conceived to be something very different. It was meant to be a whole organisation transform.

In organisations that are a hybrid of IT solutions for a none IT core offering, the whole organisation transform is seen not to take place. In these situations, traditional command control can become the dominant way of managing to the detriment of the organisations digital offering. The failures of which are often only experienced by end users (customers) and which are often never seen by managers.

Encouragingly, there are emerging a growing number of new organisations that both structure themselves, and treat people in a completely different way. The traditional 'top-down' hierarchical structures in which the vast majority of people find themselves working in today, are, in these new organisations, flatted to just two or maybe three levels. Traditional roles are gone. Pay structures are open, and management is collective. There is a radical transparency. [34]

In these organisations, the *managerial* view of those working in the organisation is that, once an individual leaves the work place they are perfectly capable of managing their own lives (xviii). So why should the organisation treat them as other when they are at work? In other words, there is trust. And the organisation puts in place the support structures needed for such an environment.

And the elements of trust, respect for people, surface the problem, collective analysis and agreed solution are also the core learning elements of an A3 approach, and have been embodied in such as the TPS for decades.

For these organisations, one thing is abundantly plain, the current established ways of structuring and managing an organisation are redundant. Moreover, for many of the emergent problems we see in society today, such as, climate change, changing of the financial paradigms [35], the traditional managerial structures are an impediment to an organisation's ability to work on, and find solutions to these problems. Simply we need to change the way we treat and trust people, organise ourselves and collaborate if we are collectively going to be able to solve problems confronting humanity.

The recognition of these new trust based integrated structures, built on what some practitioners call an Agile and Lean approach (xix) needs mention as they are successful and quite the opposite of a Tayloristic approach. But, a fuller analysis of these emergent, and successful practices is another study and outside the scope of this paper. For further background, the authors have added a number of references an interested reader may find useful to explore. [36], [37]

(xviii) If people are to be trusted, are intrinsically motivated and are capable of self-direction; why then, would you want to structure an organisation in a way that constrains such human qualities that are beneficial to the organisation, it's growth and future in a traditional hierarchical command and control environment?

(xix) Although a number in the vanguard, are not comfortable with an agile label.

2.7 SUMMARY – part 2 – (Western Management Methods)

In Part Two, we have identified a number of methods that have been pragmatically demonstrated to provide effective results;

- Shewhart established two concepts based on scientific methods; the importance of measuring the right things in context, to ensure that the reliability of the data is understood and that the data is presented in the right way, and Hypothesis testing, which is fundamental to Shewhart's thinking which is the basis of the PDSA cycle. Management uses science / technology to simplify the administration work, improve it and fulfil the needs of people and the organisation or is management a practice?"
- These were used as the basis for the TWI programme in WWII.
- This was picked up by Japanese industrialists from 1950 on and were amplified by Ishikawa, Taguchi and others. There work was drawn into the base design of the Toyota Production System, described by Jones and Womack as Lean Production. Interestingly, Taguchi's methods and Respect for people are absent from LP.
- In US, Deming, and others, translated Shewhart's ideas into TQM as a set of systematic activities carried out by the entire organisation to effectively and efficiently achieve company objectives so as to provide products and services with a level of quality that satisfies customers, at the appropriate time and price.

Some general reasons that are cited for the lack of conspicuous success of TQM which include: no clear definition of the rationale for TQM, lack of high-level management commitment and involvement and just another "fad" to improve quality. This led to the implementation of management fads such as Six Sigma, and Lean Six Sigma which were initially attractive to senior management but, eventually proved unsuccessful.

See also Appendix 4 which expands these ideas to illustrate the underlying beliefs behind these perceived behaviours and their negative. consequences.

But this is not a static situation. Methods continue to be refined. And these are explored in the latter sections.

In Section 2.8 we look at the methodologies that have withstood scrutiny, have engendered holistic and inclusive companies, and lay out an approach, with an action plan that can be used.

Societies and individuals do not remain the same forever. But what endures is the way truly innovative and learning organisations draw together the collective thinking and problem-solving force of their entire compliment to creative better products, ways of making them with less waste and at less cost to the focused benefit of their customers; which in turn has created their outstanding longevity over many decades, surviving industry-wide disruptions such as recessions and wars.

2.8 ROBUST SYSTEMS IN SUSTAINABLE ORGANISATIONS

We have examined the concerns regarding Taylorism and its descendants.

While many organisations see their market place under constant attack by competitors from other parts of the world that operate under very different methodologies. These are often, at a cursory level, dismissed as being of a cultural nature that will be wholly unacceptable and not capable of being implemented in '*our back yard'*. Sadly, that is far from right. Not only are these systems easily understandable, capable of being implemented elsewhere; Their origin was *Our-Back-Yard*, where they were refined, and practiced to great effect and reward, and then exported to a more fertile ground.

- **Can we learn them again?**
- **Do we know what to do?**
- **Is it possible to catch up?**

The answer to all three is yes. It just takes some faith to move in a different direction, apply some different thinking, and to develop a constancy of purpose toward a proven methodology. The rewards are there for the taking.

In addition, there are two key omissions from the initial work coming out of Phase one of the International Motor Vehicle Program that are fundamental to understanding the TPS. These are the work of Taguchi on the loss function and robust design which is core to the high reliability of Japanese products.

And, the use of what Shook, [38], describes as "a visual manifestation of a problem-solving thought process involving continual dialogue between the owner of an issue and others in an organisation".

What Shook is talking about is A3 Thinking which enables a simple tool, the A3 Report, as a way of structuring and sharing knowledge between teams and their members helping them to practice scientific thinking as a way of discovering and learning together.

An A3 is based on the PDCA cycle and enables teams to share knowledge with the rest of the organisation in a concise manner, whilst at the same time finding the Root Cause(s) of a problem and proposing counter Measures for comment before implementation.

Many people think of the A3 process as a problem-solving mechanism (or a structure for a problem-solving process), but at Toyota it became much more than that. It came to embody the company's way of enabling people to work together and learn effectively how to solve problems. Within Toyota (and across Japanese industry) this underpinning cultural norm is massively different to Western Management, but is necessary for the Japanese approach to succeed.

The most fundamental use of the A3 is as a simple problem-solving tool. But the underlying principles and practices can be applied in any organisational setting. Given that the first use of the A3 as a tool is to standardise a methodology to understand and respond to problems, A3 methodologies encourage root cause analysis, reveal processes, and represent goals and actions in a format that triggers conversation and learning. An example with background is given in Appendix 5.

These can be visualised as shown in fig 5 below:

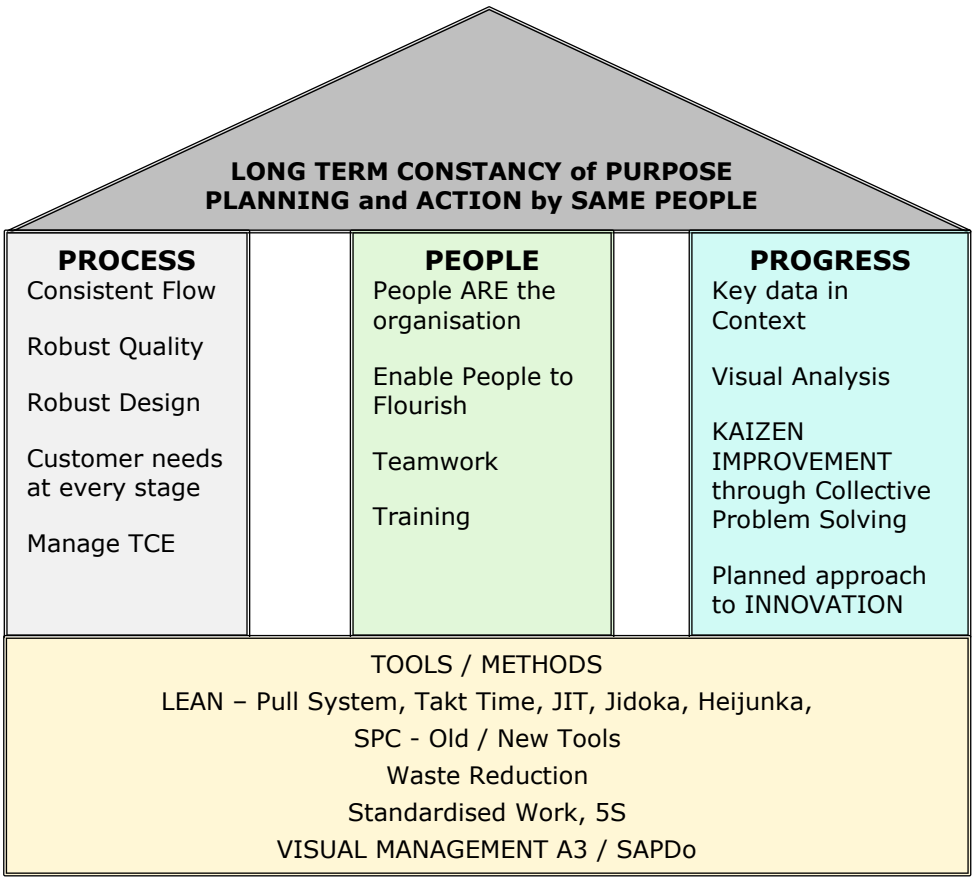


Fig 5 The pillars of a Robust System and the underpinning

A robust organisation has the capacity to sustain by absorbing and recovering from events, and, if necessary, adapting structures, systems and processes in response. This capacity is built-in through robust situationally aware management action to accomplish short term goals that serve the long-term purpose.

As Glasser [39] puts it: *"…people will only buy your products if they are as good,* [preferably auth.] *better than those made elsewhere. …that only much better management of people will make this possible." "…managers must focus on the work-place, far more than on the work."* "…[and auth.] *most managers find it almost impossible to conceptualise a quality workplace. Without this vision we will never achieve the level of quality we must achieve if we are to be competitive in an increasingly competitive world."*

And in table 3 each of the above elements are expanded:

QFD – Quality Function Deployment (otherwise House of Quality)

PD – Policy Deployment (otherwise Hoshin Kanri)

TCE – Total Customer Experience. from Carlzen [40]; *Moments of Truth.*

WHAT	WHY	HOW
PURPOSE		
LONG TERM / CONSTANCY of PURPOSE	Long-term return to stakeholders (not just shareholders)– customer defines quality, continual improvement, stay in business, good jobs.	Develop "***Reason for Being***" Statement. To include: "What we will do…" – "What we will never do…"
PLANNING AND ACTION BY SAME PEOPLE	When people are actively involved in determining the strategy and creating the action plan, they develop a sense of ownership and become far more likely to take part in improving processes.	Initial external help Training / Practice **PD**
PROCESS		
SYSTEM DELIVERS CONSISTENT FLOW	Quality products / services that exceed customer requirements, consistent flow is key to continual improvement.	Initial external help **LEAN**
QUALITY IS No.1 MANAGEMENT JOB	Senior managers understand what quality the organisation needs to deliver in order to keep customers. Focus on quality starts at the top.	Initial external help **QFD**
MANAGE TOTAL CUSTOMER EXPERIENCE	Provide value at every customer contact with the product or service, or with a member of the organisation.	Understand **TCE**
CUSTOMER IN MIND AT EACH STAGE	Understanding the wants and needs of customers and users at every stage in total customer experience is a critical to providing ever-better value to customer.	Understand **TCE**
PEOPLE		
PEOPLE ARE THE ORGANISATION	They deliver quality to the customer.	Training / Practice
ENABLE PEOPLE TO FLOURISH	Standardised tasks (5S) are the foundation of continual improvement and employee engagement.	Initial external help Training / Practice
PROGRESS		
MEASURE KEY DATA IN CONTEXT	Understanding what is happening now is key to improvement	Start **A3 program**
VISUAL ANALYSIS LEADS TO ACTION A3 / PDSA INCLUSIVE PROBLEM SOLVING	Create a consistent approach to solving problems throughout the entire organisation. Visual method reduces complexity and keeps focus on the problem. Generates alignment and consensus. Surface problems for collective solution.	Start **A3 program**
COLLECTIVE PROBLEM SOLVING ENCOURAGE COOPERATION	Use everyone's skills in a cooperative effort to improve products, services and the way things are done. Plan Slowly, Act Fast; as basis of continual improvement	Start **A3 program**
PLANNED APPROACH TO INNOVATION	It is good to introduce, by innovation, a new product that will do the job better. It is necessary to innovate, to predict needs of the customer, and give them more.	**KANO**
PEOPLE TRAIN PEOPLE TO WORK ON PROBLEMS	By having your people work collectively on solving problems in their immediate sphere the organisation is future event proofed, stronger and more knowledgeable.	Use **A3** thinking for **Teaching** to **Learn** and **problem solving**

Table 3 The purpose behind the Pillars of a Robust and Adaptive System.

2.9 EPILOGUE / CONCLUSION

Had Taylor's thinking remained as a discrete work at the start of the twentieth century, this paper would be superfluous to requirements. Unfortunately, his Scientific Management may not have been adopted in total, but its elements can still be seen everywhere.

In part 1 of this paper, we looked at the origins of management structure and its development into the legacy systems both seen and still in use today. The problems associated with Tayloresque theories and practice are explored, along with their derivatives of Job Analysis, Operations Research, Six Sigma, Lean Six Sigma and Agile.

In many ways Taylor's system was of its time. The way people were both regarded and consequentially managed was simply a reflection of that time. However, over the decades the lives of people have changed markedly. People are better educated, healthier, have more disposable income and enjoy a better standard of living with more free time.

Additionally, the understanding of human behaviours and interactions has grown a pace and the sciences in this area had well founded, and peer reviewed, works to explain much human phycology and behaviour.

These elements were not present in any of Taylor's or the Gilbreth's models of how to manage people. The problem is that whilst these human characteristics are well known, and in some naive form find their way into such as renumeration systems, the basic element of the Taylorist model for managing a business are basically unchanged for the last century.

In 1924 Walter Shewhart began to develop his theories about the quality of manufactured products and proposed statistical methods for examining, understanding and showing how to control quality of products. Whilst at Hawthorne, Shewhart met and influenced W Edwards Deming who went on to champion Shewhart's methods. At the time Deming, an engineer and statistician, was working for the US Bureau of Labor Statistics. Deming became a proponent of Shewhart's methods and developed them into a broader management philosophy.

This led to the great strides made in the early 1940s in America with the development of the TWI (Training Within Industry) initiative of Dooley (and others) which hugely advanced American manufacturing capability and productivity. And at the same time laid the foundations for management practice, training for employees and mutual cooperation between business and unions. At the end of the war, there was more demand than capacity in post-war America, and TWI just fell out of favour.

By contrast, after the second world war in Japan, General Douglas MacArthur understood that if efforts were not made to re-build the industrial infrastructure of Japan, it was highly likely that it would descend into chaos with the attendant issues for the occupying powers. The fundamental decision was to bring the expertise in manufacturing from the USA to Japan.

Chosen for this task were (amongst others) Deming and Juran, who taught the Japanese their statistical methods and associated management theories. These grew into the success stories that have abounded for decades about Japanese manufacturing prowess. But this is not a static situation. Methods continue to be refined. And these were explored in the latter sections.

In part 2 we examined if there is a science of management, and conclude that two methods are applicable.

TAYLORISM IS AT A DEAD END

Despite the near ubiquitous range of adoption of Tayloresque ideas, there are major problems as a result. The most common criticism of Taylor is that his approach is too mechanistic - treating people like machines rather than human beings, with the result being a one-size-fits-all approach to people management and training that fails to recognise the complexity of human motivations.

Andrews (1980) [41] says "we have adopted Taylor's notion of the "scientific" approach in which we try to discover patterns and laws, and have replaced all notions of human intentionality with a firm belief in causal determinism for explaining all aspects of corporate performance. In effect, we have professed that business is reducible to a kind of physics in which even if individual managers do play a role, it can safely be taken as determined by the economic, social, and psychological laws that inevitably shape peoples' actions."

In many ways Taylor's philosophy lies in direct opposition to today's best practice. And the root problem of so-called Scientific Management assumes the single best method is invariant, when in practice it cannot be due to inherent variation of both the process and the person.

If anything, the experience of the last 20 years has taught managers that in the new business environment such "scientific" principles are a recipe for disaster. In fast-changing markets, the fragmentation of work, the separation of planning from execution, and the isolation of workers from each other create rigid organisations that cannot adapt quickly to change.

Societies and individuals do not remain the same forever. But what endures is the way truly innovative and learning organisations draw together the collective thinking and problem-solving force of their entire compliment to creative better products, ways of making them with less waste and at less cost to the focused benefit of their customers, which in turn creates their growth and survival.

As a result, managers must now rethink the fundamental elements of Taylor's system: work organisation, employee motivation, and the task of management. Using a plurality of methods for increasing productivity, which should be tailored to workers' needs. Feedback, both from customer and employee, should be encouraged and decision-making shared between workers and management to engender a greater sense of participation and ownership, greater engagement, and a stronger sense of collaboration within the organisation.

WHAT A TAYLORIST MANAGERIAL APPROACH MISSES IN TODAY'S EMPLOYEE MARKET:

In 1.4 we expanded on the reasons for Taylor's approach to management, which in the 1910s when the educational level of the manual workforce was limited, was a sound and pragmatic way to organise. It would have been a natural and logical step to separate the planning and direction of work from those engaged in its execution.

Since the mid part of the last century, successive governments in many nations have committed to the development of practical and theoretical educational skills in their populations. The outcome of these investments has been a more highly educated and skilled population. This of course translates into a more highly educated and competent workforce. A workforce that is capable of contributing to the knowledge, skill set, and growth of any organisation in which they are employed.

It would seem then unfortunate, that any employer should not avail themselves of the skills and talents such a workforce can bring to the organisation. Both experientially, and as reported, it is all too common that many organisations employ their workforce in a manner that commits them to a rigid hierarchy of responsibilities for the direction of their daily work handed down by others.

Those undertaking the daily work are in a unique position to understand and learn from the effectiveness of the tools, procedures, and scripts they are directed to use by those in higher authority to improve the delivery of both services and goods to the customer.

Any organisation that does not take full advantage of the input from such employees effectively closes itself off from a rich source of learning, understanding and growth.

In the last part of 2.6 on Agile, we have shown that businesses who fully integrate the knowledge learning and understanding of all their employees stand to make greater strides to the benefit of both the business and the customer.

The differences between the application of a *Tayloristic* approach, and an *Inclusive, Adaptive, and Learning* approach is summarised in two tables:

- *Tayloristic* as set out in Appendix 4, and
- *Inclusive, Adaptive, and Learning* as covered in detail in section 2.8 (fig 3).

The latter clearly demonstrating the advantages of using the entire complement of the business to develop solutions for the customer / consumer, and to continually learn and grow to the benefit of all.

APPENDIX 1 IS THERE A SCIENCE OF MANAGEMENT?

Over the last 50 years business school research has increasingly adopted the "scientific" model; an approach that Hayek (1989) [1] described as "the pretence of knowledge." This relies on little evidence, excludes any role for human intentionality or choice, and uses unfounded assumptions and deductive reasoning (Bailey & Ford. 1996) [2].

Combined with the pretence of knowledge, this ideology has led management research increasingly in the direction of making excessive truth claims based on partial analysis and both unrealistic and biased assumptions.

The primary endeavour of business school academics over the last half century has been to make business studies a branch of the social sciences (Schlossman, Sedlak, & Wechsler 1998) [3]. They have adopted the "scientific" approach in which they try to discover patterns and laws and have replaced all notions of human intentionality with a firm belief in causal determinism for explaining all aspects of corporate performance. In effect, we have professed that business is reducible to a kind of physics.

Friedrich von Hayek placed the blame on "the pretence of knowledge," which is how he titled his talk (1989: 3-7). "It seems to me that this failure of economists to guide public policy more successfully is clearly connected with their propensity to imitate as closely as possible the procedures of the brilliantly successful physical sciences. This assumption helps in structuring and solving nice mathematical models. But then, to make the model yield a solution, some more assumptions have to be made."

Elster [4] argued that categories such as causal, functional, and intentional, can be used to explain three different modes of understanding the world around us;

Causal; for the sciences of inorganic matter, such as physics, the only acceptable mode of explanation is the causal mode.

Functional explanations play an important role in the sciences of organic matter, such as biology. All one has to do to explain a particular feature of an organism, or some aspect of its behaviour, is to demonstrate that the feature or behaviour enhances its reproductive fitness. The reason such functional explanations are adequate, however, lies in the availability of an overarching causal theory: that of natural selection.

Intentional explanations, such as those based on some notion of actor, imagination or will, defined as "the power of minds to be about, to represent, or to stand for, things, properties and states of affairs". There is no role of intentionality within biology or physics as a guide to individual action.

Management theories at present are overwhelmingly causal or functional in their modes of explanation. Ethics, or morality, however, are mental phenomena. As a result, they have had to be excluded from our theory, which cannot be right since organisations are essentially social phenomena.

Business cannot be treated as a science, and we have to fall back on the wisdom of common sense to develop both a practical understanding of, and some pragmatic prescriptions for, "phenomena of organised complexity" that the issue of corporate governance represents.

Elster offers the metaphor of a good tool box that consists of a diversity of the tools that constitutes the real utility of the collection. He suggests that the social sciences need to resort to a large collection of theoretical tools--models, modes of analysis, quantitative techniques, and the like--in order to explain diverse social phenomena.

Management is a practice (skill or craft) rather than a science or a profession, though it contains elements of both. Management applies science, or more correctly, technology to implement action, to improve and to fulfil the needs of people. A comparison of Science v. Technology is given in panel 3 in 1.3.

Drucker (1954) [first?] writes that management can never be an exact science, management is a practice rather than a science or a profession, although it contains elements of both. This is probably the underlying theme of this paper.

In Beyond the Hype, Eccles and Nohria [5], look beyond today's management fads to discover the timeless aspects of effective managerial practice. The flood of management business fads and fashions in the 80s and 90s have obscured the essentials of management and pushed executives into a frantic search for the acquisition and implementation of the latest how-to.

Alvarez, (1997) [6] argues that managers have the potential to fall easily into the temptation of simplistic formulas because of the simultaneous fixed targets of organisational outcomes and high uncertainty, typical in today's volatile environments. These two features, inflexible targets and high uncertainty drive the need for off-the-shelf explanations. Yet it is adaptability that matters.

Eccles and Nohria identify the essence of management not in technical procedures with the potential of being standardised or translated into formulas, but in some pragmatic and highly tactical competencies, effective in "getting things done," in accomplishing goals in social settings. The pragmatic essence of the managerial job in the notion of "robust action," that is, in arranging the mix of organisational elements (from systems and formal structures to shared values and styles) in ways that facilitate the accomplishment of short-term objectives while preserving long-term flexibility.

The skill / practice of "robust action" proposed by Nohria and Eccles are; first, acting without certitude; second, constantly preserving flexibility; third, being politically savvy; fourth, having a keen sense of timing; fifth, judging the situation at hand; sixth, using rhetoric effectively; and seventh, working multiple agendas.

The principles of "robust action" give us more evidence that what managers do, that is getting action, which springs from a set of competencies not dependent on formalised knowledge. Thus, robust action is not easily conducive to standardisation as scientific management nor, therefore, to professionalisation.

However, practical managers use elements of scientific methods to good effect. As opposed to Taylor’s over exaggerated claims for his scientific management method, we will consider the two key elements of scientific methods; interoperability of data and hypothesis testing, which have been used by very successful management since World War II.

Appendix 2 MOTIVATION

A further, and at the time largely irrelevant, difficulty with the Taylor method, was the absence of understanding of what really motivates people. It was assumed at the time of Taylor, that workers were solely motivated by money and their standing in society. And to some extent at a time of low education, low income and few readily available commodities this view would be largely relevant. The difficulty arises once the pool of available labour becomes more healthy, better fed, better educated and where there are a broad range of tradeable commodities available. When this occurs, the focus of the pool of labour changes. No more are they singularly motivated by financial reward, but become increasingly motivated by a desire for the freedom to think, to question, and in addition, they increasingly require reason for the tasks in which they are engaged. That is, they start to require more control over what they are paid to do. Indeed, they start to question what it is they are being asked to do, and why they are being asked to do it.

Lots of research has been done on motivation, some more helpful than others. Of particular use are the theories developed by Frederick Herzberg [7]. His conclusion was that whilst some factors in the working conditions were found to increase motivation, called *Growth factors*, there are also some factors had the power to demotivate staff if they are not present. He called these *Hygiene Factors.*

These environmental or hygiene factors are salary and quality of supervision. No amount of additional salary, for instance will increase motivation beyond a certain level. However, a low salary compared to the market place will demotivate. Motivation on the other hand was bound to factors such as achievement, recognition, the work itself, responsibility and advancement and growth.

This change in motivation and need was developed by Abraham Maslow [8] in his work on hierarchical needs. His theory is that individuals need to have their most basic needs met before they can become motivated to engage with and achieve higher needs. His work is often presented in the form of a pyramid of needs as shown in fig 1:

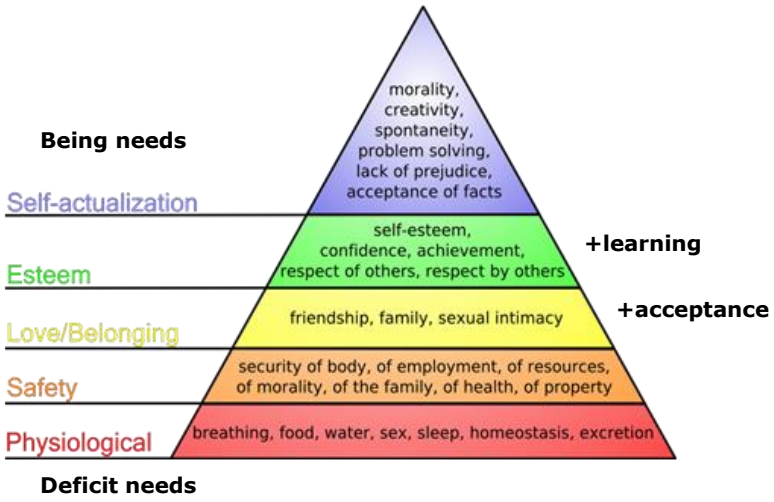


Fig 1: Maslow's description of people's hierarchical needs (with additions) in the form of a pyramid. The most basic needs are presented at the bottom of the pyramid, with the higher order needs at the top. *www.wikipedia.org accessed 2003*

These motivations were noted and commented on by both Deming [9] in describing intrinsic (good self-motivation) and extrinsic (bad overt external demand or bribery) motivation and "*The Forces of Destruction"* unwittingly applied by managers pursuing methods of control that rob people of their pride in work. And also, by Henry Mintzberg [10].

More latterly, the power of intrinsic motivation and the failure of extrinsic motivational pressures and environments and the damage they do to moral and learning have been further studied by Alfie Kohn [11], and demonstrated by Mihaly Csikszentmihalyi [12] in his studies of *Optimal Experience* and Dan Pink [13] in his work on what drives people.

Csikszentmihalyi, describes how people get into a FLOW zone in small steps which includes a growing sense purpose and ability.

Chen [14] shows graphically (fig 2) how people emotionally experience new situations. And this can translate directly into the work environment. putting people into tasks where the purpose is not clear, where the task is unfamiliar or overly demanding, or counter to their beliefs of doing good (what is right) then they do not engage to develop higher skills at the task. Conversely, if the task is too menial, they also disengage due to boredom. To engage people effectively, they need to be in the '*flow zone'* where they can see purpose and hence engage to be more skillful and effective.

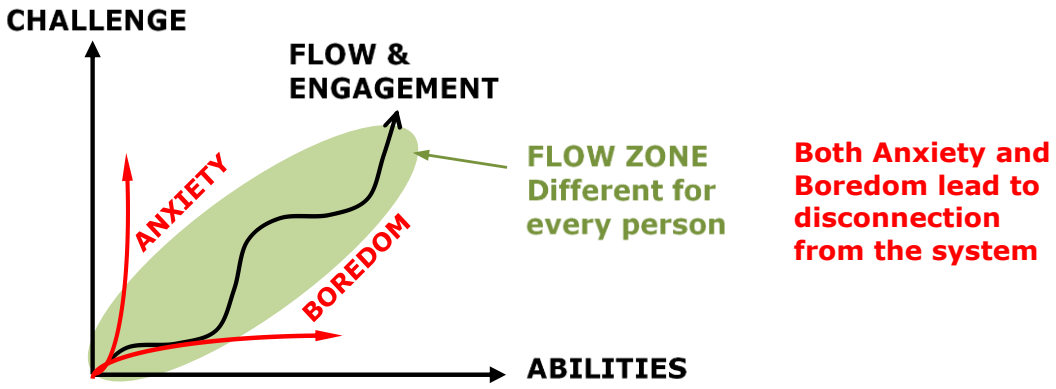


Fig 2: Csikszentmihalyi on Flow, and as interpreted by Xinghan (Jenova) Chen.
Diagrams by Chen from: ***FLOW IN GAMES (AND EVERYTHING ELSE)*** [14]

That is, if a team member is introduced to a new concept, (way of doing things), that is at a tangent to their current experiences, then the Team Leader needs to ensure they are familiar with both the Purpose of the Method and are introduced at a level that the new approach does not create anxiety and hence an aversion to the new method. Continual training is also essential. People are most engaged with their roles when they are comfortably in their *Flow Zone*.

In his work, Pink describes in detail a series of motivational experiments, repeated in several countries and with subjects at different levels of educational achievement. And who were living above the basic needs level as described by Maslow. What was clear from all the experiments, which gave the same results regardless of geography, was that extrinsic motivation did not result in a subject applying greater effort into their tasks. But did show that people became motivated to gain more reward at the expense of the organisation.

Put simply, even at work, people are motivated by other drivers than financial reward. These are (in order of importance) Autonomy, Purpose and Mastery. That is, in employment, people need to feel free to express themselves (often to the good of the organisation) and to believe in the reasons why they are engaged in the tasks and focus of the organisation. Without these two drivers, people do not put forward best efforts to the organisation's purpose. (see also Reason for Being and what managers need to do in Table 3 in 2.8)

Their findings show that whilst an amount of renumeration for labour is needed, it is not the main driver. Indeed, the greater the incentive, the less likely it is that an employee will strive harder at the task in hand, but will strive for incentive or reward. And both Csikszentmihalyi and Pink found and demonstrate that people are motivated by other higher order motivators.

It is these three drivers (Autonomy, Purpose, and Mastery) that Tayloresque management practices are at odds with. Little surprise that Taylor's methods yield such poor results in today's business and organisational world.

But if we are to engage team members then perhaps we should do so through the same mechanisms many use in choice activities in their leisure time.

Psychodynamics, also known as psychodynamic psychology, in its broadest sense, is an approach to psychology that emphasises systematic study of the psychological forces that underlie human behaviour, feelings, and emotions and how they might relate to early experience. It is especially interested in the dynamic relations between conscious motivation and unconscious motivation.

Anonymously ask a broad section of employees from any company what they do in hobby or volunteering work when away from their paid employment. What you are likely to find is that a good proportion are engaged in volunteering work either in a none supervisory role, or in a supervisory role where they are often engaged in activities of a higher order managerial role that their immediate manager at their place of paid employment.

Motivation is widely misunderstood and done badly. We suggest that motivation means ***wanting*** to do something for its own sake. That is, people are intrinsically, not extrinsically motivated. **And we are all born with it!!**

Managers cannot motivate someone, although many believe they can (see Hertzberg '*One More Time…*' [15]); but managers certainly can demotivate people. People need to motivate themselves, and they are intrinsically self-motivating, see Kohn.

It is necessary to understand that you and everyone else do things for their own reasons not for those of leaders or managers (i). It is possible to coerce or incentivise people to take certain action. However, in those circumstances the reason they take that action is because they are avoiding pain or going for a reward. They are not interested in the work itself or, worse, the customers. Using coercion or reward always has unintended consequences for the organisation.

In many organisations the decision making, and hence problem-solving activity is regarded as being in the province of managers. After all, it's why the renumeration packages are what they are.

But is there another approach? How can an organisation harness this intrinsic and powerful inbuilt motivation in people? And, how much more can be achieved in an organisation if instead of a few managers dealing with all the internal and external buffeting an organisation is subjected too in the course of its normal business activities, the whole workforce could be engaged in the same survival activity?

How do you harness the power of your people, your most important asset?

The key is treating all your people with respect, and in engaging all your people in learning and developing your systems. Do not separate planning from doing.

Go often to where the work is carried out, and both see and learn for yourself. Management is a visible endeavor.

See also Lean in 2.4, Table 3 in 2.8, and Glasser [39] part 2.

(i) people will do things for leaders if they believe in the cause.

Appendix 3 ROBUST QUALITY

In this section we discuss another major element of an organisation's reasoning and purpose, that of Robust Quality (ii).

But what do we mean by robust quality? Here we define Robust Quality as that which ensures that the products or services the organisation delivers to its customer (iii) are of such quality that even when perturbations happen within the organisation to push the product or service away from the desired physical or service delivery quality, they will have such little effect on the outcome because the organisation has such systems in place that the quality of the product (or service) is not adversely affected by such excursions. In basic terms that means on target with minimum variation.

To describe this, we will explore why manufacturing to tolerance, or delivering a service within agreed limits is not sufficient. And why centring the process (or your service delivery) on the most acceptable target with minimal variation embedded in the systems that produce that service or product to the customer is essential.

There is a common belief that high levels of quality cost more. Even to the extent that achieving high levels of quality is unnecessary, and not wanted by the customer. This is unfortunately not correct and even small deviations away from the desired target can and do cost the organisation financially more than is apparent. Many times, more.

ACCEPTABILITY v DESIRABILITY

A graphical example of the two different views, within limits, and constant pursuit of ever better quality with a focus on being on target with less and less variation was described by Kosaku Yoshida [16] and is shown in fig 3:

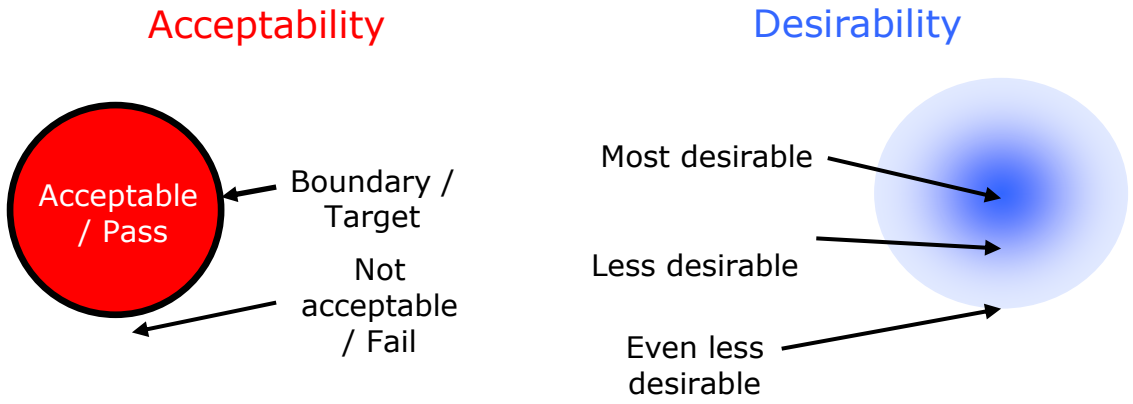


Fig: 3, two different views of a quality. One assumes that better quality is not required (*acceptability*) the other sees that higher levels of quality (desirability) [*on target with minimal variation*] is less expensive and also offers greater protection of quality when perturbations challenge the organisation.

(ii) by definition, Robust Quality requires that the internal processes are of Robust Design and the products themselves are of robust design for the manufacturing process and for the purpose to which customers put them.

(iii) by customer we mean both the next person within the organisation to receive the output from an internal process; And, the final customer or consumer who actually pays for the product or service.

To work to a standard is to assume that any result that lies inside the target, or between the limits is acceptable. But: *'If you are working on acceptability concepts, that is the quickest way to bankrupt your company'* Dr. Kosaku Yoshida, 1995

A more formal and robust description of the losses encountered when a product or process is not centred on target with minimal variation was developed by Dr Genichi Taguchi. His work, generally called the *Taguchi Loss Function* describes both graphically and in a quantifiable financial way, the magnitude of loss suffered by an organisation, and ultimately across society of poor quality.

Both Dr Taguchi, and many others have fully described how such losses occur under several common practices that are considered to be adequate, but which hide significant losses to the organisation both financially and in reputational terms.

Below, we describe Taguchi's Loss Function, but also refer the reader to: Henry Neave [17] chapters 11 and 12; Wheeler and Chambers [18]; Taguchi and Clausing [19]; and Lean Six Sigma Definition [20] whose description also includes a useful example relating to quality and loss of low quality in produce (food).

THE TAGUCHI LOSS FUNCTION is a methodology to describe and quantify how losses both financially and in quality grow the further away from target the output of a process or customer service becomes. This applies equally to drift above and below the target value.
As far back as Taylor, the acceptability of items produced by a process were required to lie between an upper specification and a lower specification (iv); generally measured by means of GO / NOGO gauges. The concept of lower and upper limits became imbedded in the design and manufacture of massed produced items; and has found its way into service delivery.

Traditionally a specification be it a dimension (i.e. mm), colour (shade changes), or even a physical attribute (sugar content), would be specified as a specification (target) level with both a LSL (Lower Specification Limit) and an USL (Upper Specification Limit). The black lines in Fig 4. As an example, let us assume that the target limit is 20 and that the LSL is 15, and the USL 25. The implication is that an item with a measured value of say 24.95 is acceptable and is satisfactory to the customer. Whilst a value of 25.05 is not acceptable to the customer. That is a change in value of 0.1.

(iv) The historical determination of these limits was only rarely scientifically derived, more often arbitrary. And there are losses associated with their deployment, particularly in term of being able to fit components together, or where components were too loose to give sufficient life. A modern variant is where the design calls for a particular tolerance; production claims that it will cost too much to make economically, and there ensues a negotiation between design and manufacturing until a compromise is reached. A Taguchi approach asks that both parties strive for minimum variation based on practical experience.

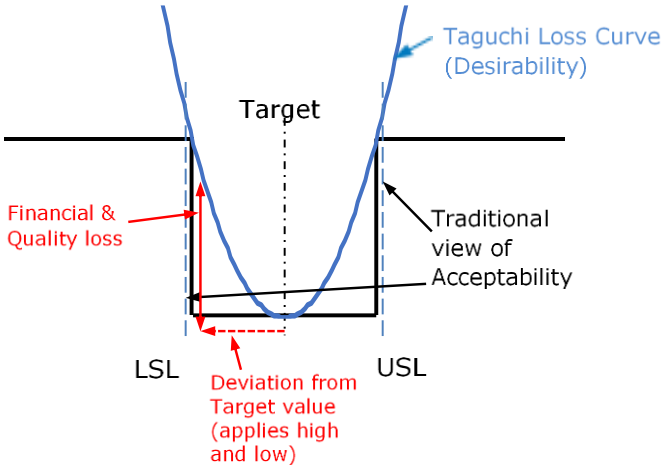


Fig 4: Traditional upper (USL) and lower (LSL) specification limits for a system output {black lines}, and the Taguchi Loss Function {blue curve} showing how losses {red lines} increase the further away from the target the system output becomes.

The Taguchi approach is to say that any deviation from the target (most desirable) value of 20 will incur some current and future loss in an assembled component, and will be perceived by the customer as less desirable. As the deviation grows from the most desirable value the customer will become more dissatisfied. In other words, the perception of quality does follow a cliff edge model; acceptable, until you fall off the cliff. It is a gradual, and growing dissatisfaction with the product (v). Wheeler's underlying message is that your objective is to be on target with minimal variation.

(v) This was definitively demonstrated to Ford in 1983 and as recognised by John Betti, VP Powertrain and Chassis Operations. See Neave [17] pp161.

APPENDIX 4 CURRENT WESTERN PRACTICE AFTER TAYLOR

Breaking away from Taylorism

	UNSPOKEN BELIEFS	RESULTING BEHAVIOUR /ACTION	REALITY
PURPOSE	Shareholders own the organisation	The purpose of the organisation is to maximise profits in the short term. Drive down costs /waste.	Shareholders do not in law own the organisation. The ownership belief drives short-term behaviors that are detrimental to the long-term benefit of the organisation.
	Managers are well educated, intelligent experienced people who deserve their status. Assumes the leader knows best.	Planning is a management activity, they determining the strategy and create an action plan. In other words, control is strictly top-down. Command and control of work by managers. The management controls inventories, scheduling, planning, reporting. It sets the budgets and targets.	In practice it is remotely likely that today's managers will have greater knowledge about specific operations than those undertaking the operations. Those who do the doing, must do the planning. And targets drive behaviors to meet the target at all costs, even if the resulting actions are detrimental to the organisation.
PROCESS	The organisation is at its most efficient when every activity / worker is optimised. If each individual, each activity is optimised, in isolation, then the whole organisation will achieve optimal performance.	The organisation is a set of self-managed departments or "silos". Production is to be efficient at every stage, against arbitrary targets. Monitor worker production to ensure that they are efficient. Managers should break down each employee's job into more manageable, bite-sized tasks, using time and motion studies as the way to do this. Develop tools such that a worker can work harder for longer.	The purpose of the organisation is to be effective for the customer. Being effective is of greater benefit to both the customer and the organisation than is efficiency. Simply one can be 100% efficient at doing completely the wrong thing for the customer. Effectiveness also comes at lower cost to the organisation.
	People must be held responsible.	The purpose of the organisation chart is to specify responsibilities and duties; so that management can apportion blame and punishment.	People work in a system, and it is the system that drives behaviours. When an undesirable event occurs, it is always the system that needs to be addressed. i.e., how did the system allow this to happen.
	Customers are a resource to maximise revenue.	Market share vs arbitrary targets. Quarterly sales initiatives. Minimise sales days. Quality is the responsibility of the QA department	Customers are the long-term source of an organisation's wealth. The organisation needs them to keep returning. Leave them with a sense of being cheated and they will go elsewhere. And finding new customers is expensive.
	Suppliers are a resource to minimise costs.	Competitive tendering. Closed bid tenders. Continued pressure on price.	If the organisation beats up on its suppliers, they will find a way to get even. Do business in a competitive world is hard enough? Why then does the organisation want skirmishes on more than one front?
	Managers solely understand how the work works. Workers are uneducated, undeserving people who are there to do the work without question.	Workers have no input to job analysis; it happens to them without their involvement. Little feedback from workers is needed, or expected. No contribution is expected of workers.	Investigations reveal that most workers are highly intelligent people. There are many instances where out of the formal work environment, workers in volunteering roles hold down influential positions, often with a greater managerial requirement than their boss in the formal work environment.

	UNSPOKEN BELIEFS	RESULTING BEHAVIOUR /ACTION	REALITY
PEOPLE	People are a resource to be managed efficiently.	Rules and policies that are designed to restrict and control people's behaviour; which prevents collaborative working.	Left to their own devices, and effectively guided, self-managing teams will outperform those individuals a classically managed and controlled work environment.
PEOPLE	People are motivated by financial reward. Workers are greedy and lazy; they need to be motivated by both punishment and reward.	Command and control management style works through extrinsic motivators such as threats, authority, and monetary incentives, all of which prevent or even replace employees' natural intrinsic motivation. They are judged, and ranked, against arbitrary output targets. Payment by results or piece work are the norm.	If people are motivated solely by financial reward, how come there are so many people engaged in volunteering roles which demand long hours for no reward other than the satisfaction of a life saved or a job well done? Encouraging people to get rewards does just that; they fight for the reward and disengage with the organisation's objectives and customers.
PEOPLE	There is one optimum way to carry out each and every task, managers role is to enforce this. Some workers are better than others at a given task	Work with employees to retrain and recalibrate them, so that they are exactly following the most efficient way to perform their job This often involved looking at the most efficient workers to identify why they were so efficient.	Focussing on a 'one best way' denies the system the opportunity to learn, advance and progress beyond where it is. The organisation stagnates and eventually becomes moribund.
PROGRESS	Management consists of Budgeting, Targets and Posts.	Limited understanding of what is happening. Management sees aggregated visible data, often as periodic point comparisons against last week, last month or last year. Trends are poorly understood. Arbitrary output targets prevail.	The role of a manager is to ensure that the self-managing teams under their auspices have all the resources and space to accomplish their agreed objectives without hinderance.
PROGRESS	Improvement / innovation is a management / expert lead activity.	Projects carried out by experts – internal or external – who have problem-solving expertise could be transferred to any situation. Sponsored by management, without their involvement. Consisting of finite projects to improve efficiency and reduce costs against arbitrary targets. Each improvement activity is generally a managed project, perceived as an improvement, but which results in a lack of co-operation from employees leading to the loss of better solutions than people can envisage collectively individually. Communication obstructs improvement and innovation. Limits engagement and commitment, which impedes creativity and decision-making. inhibits Employees feel less respected, and have less desire to contribute.	A3 Thinking (or Managing to Learn; Shook) makes those responsible for the day-to-day operations also the go-to source for improvement and root cause analysis investigation. The cohesive approach asks team members to 'surface' problems they see in the daily pattern of work, and to discuss such observations with their manager for support and resources to tackle the identified issue. When solutions are worked out between the members of one team and others that may be affected, the finalised change in procedure is invariably agreed by all before implementation; and after implementation sticks better. This method means that people are part of the change; change is not done to them.

APPENDIX 5 A3 FOR PROBLEM SOLVING AND TRAINING

A3 THINKING

At Toyota, they use a problem-solving method that generates knowledge and helps people doing the work to learn how to learn. Company managers use a tool called the A3 (named after the international paper size on which it fits) as a key visual tactic in sharing a deeper method of thinking that lies at the heart of Toyota's sustained success.

A3 thinking s serve as mechanisms for managers to mentor others in root-cause analysis and scientific thinking, while also aligning the interests of individuals and departments throughout the organization by encouraging productive dialogue and helping people learn from one another. A3 management is a system based on building structured opportunities for people to learn in the manner that comes most naturally to them: through experience, by learning from mistakes and through plan-based trial and error.

The A3 provides the mechanism for wide dialogue and participation, leading to higher engagement. The aim of this tool is to convey a task on a single page, using a highly visual format with limited text. Using the A3 Storyboard format enables progress to be explained in five minutes.

Improvement needs to follow a structured pattern / approach. Which needs to be applied consistently across all processes and teams in the organisation.

There is no single template for an A3 Report, Proposal, Improvement, Progress and Summary are four formats regularly used. But these can be adapted to the situation in the organisation.

Otherwise known as the Quality Story, an A3 Report is deceptively simple. It is composed of a sequence of boxes (seven in the example) arrayed in a template. Inside the boxes the A3 Report team members use the following order, to: (**1**) establish the business context and importance of a specific problem or issue; (**2**) describe the current conditions of the problem; (**3**) identify the desired outcome; (**4**) analyse the situation to establish causality; (**5**) propose countermeasures; (**6**) prescribe an action plan for getting it done; and (**7**) map out the follow-up process.

Background	**Future State & Countermeasures**
- Why do we need to work on this? - Context - Importance	- Actions being taken to address the issue (what, who, when) - Quick fixes (Containment actions) - To Be process map
Current State	**Impact**
- Problem statement/definition - As Is process map - Scale of the problem (data)	- Results achieved - Trend graph (before/after)
Objective	**Follow-up**
- Target level of performance - Desired outcome	- Actions still required (what, who, when) - Learning points to share
Root Cause Analysis	
- Fishbone diagram - 5 Whys - Data (Pareto, Scatter diagram)	

Not shown implicitly in the diagram above is the name of the author, or owner, of the A3. But this is most important. In practice, this person's role is to become *"The Current Local Expert"* on the problem, it's investigation, it's communication, it's collective analysis and the agreed solution deployment control. By this method, people are taught to investigate, communicate, learn and learn how to manage to the benefit of the customer, the organisation and everyone in the organisation. It is part of *Continual Improvement*.

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END

APPENDIX 6 Angélique Macrez's Visual Summary of this paper

Moving from **Taylorism** to **Learning Organisation**

Source: *Breaking away from Taylorism: Robust systems in sustainable organisation*, Peterson, G.T and Leach, K.G. Nov 2020

Taylorism

Scientific Management

"Invariant method"

Simplify jobs increase productivity

Model of management based on:
- Command and control approach,
- Financial reward,
- Separating inspection from production and planning from execution.

Principles vs Concerns

Break down job into smaller steps to identify most efficient way	1	Little use of education and creativity by employee
Employee trained by specialist manager	2	One right way and then suppression of initiative and potential for discovering new and innovative ways
Manager for planning and worker for execution	3	Worker paid for doing and not thinking which makes production jobs monotonous
Worker monitored for doing work '*the only way*'	4	Worker not trusted to behave appropriately without management control
A fair day's pay for a fair day's work	5	Effort on achieving quantity with less focus on quality

Money driven Employee

Go / No Go to control tolerance assuring quality

Management as a practice

Using Scientific Methods and considering variance of both process and human

Sense of purpose and Quality driven Employee

Focus on quality starting at the Top – critical to providing even better value to customer

Workplace where feedback both from Customer and Employee encouraged. Decision-making shared between workers and management to engender greater ownership, engagement and sense of collaboration.

Purpose for being	5	People actively involved in determining the strategy and action plan developing sense of ownership
Robust system; Plan slowly Act fast	4	Running organisation as a system, Understanding what motivates people, Using data to drive improvement
A3 thinking (PDCA) reduces complexity and keeps a focus on a problem	3	Enabling people to work together and learn more efficiently
Robust Design for high reliability of product	2	Deviation from the most desirable target will occur future loss in the assembled component as perceived less desirable by the customer
Human psychology & behaviour	1	Drawing together collective thinking and problem solving to creative better products and ways of making them

Productivity tailored to workers' needs

1910

Job Analysis

Process of determining the scope and qualifications to get the job performed successfully with no real input from workers.
To help get the right Talent in the right place and time.
Needs for change to be considered as job evolves.

Operation Research

OR uses techniques / methods involving mathematical models in the pursuit of improved decision – making and efficiency. Modern applications of OR can now solve problems with lots of variables and constraints, still emphasising the number at the expense of human element.

1930

SQC and Hypothesis

Shewhart first to apply the 2 basic scientific methods to industrial production:
- Control charts to control variability of products and materials
- Hypothesis testing with the introduction of the Plan-Do-Study -Act PDSA cycle;

Both contributions continue to influence the daily work of quality.

1940

TWI

USA "Training Within Industry" program during the second world war – Three pocket cards **"J"** programs for supervisor to use for reference: Job Instruction, Job Method and Job Relations based on the PDSA cycle: If… - Then…, i.e. Cause and Effect Analysis.

1950

Deming wheel

Deming stressed the interaction among design, production, sales & research and the 4 steps should be constantly rotated with quality of the product and service as the aim. PDCA and QC story (A3 report) became the foundation for improvement (Kaizen).

1980

TQM

A philosophy more than a technique, everyone to think customer' satisfaction as team oriented goal and use PDCA cycle to accomplish the change,. and remember that improvement happens step by step.

1990

ISO 9000

Quality assurance to prevent non conformance. A management standard that goes beyond product conformance to how product is made and service delivered.

Six sigma

Method to reduce defect and achieve six sigma quality (i.e. 3.4 DPMO) and claims to be improving profitability.

2000

Agile

Key idea to develop applications alongside the people who use them. But remember that digitisation needs to follow good system design to align customers' needs. The order has to be Purpose, Process & How.

Lean Six sigma

Combining two fundamentally different approaches to maximise efficiency and highest quality (i.e. reducing time, cost and deviation from quality specifications throughout the organisation).

TPS Toyota Production System primarily based on 3 values: Flow, Continuous Improvement and Respect for Customers and Employees. TWI **'J'** Cards still used.

Lean Set of practices that create an environment for learning (e.g. Kaizen, Kanban, Standardised Work, Visual Management, Ishikawa) with proven results in mass production.

Purpose, Planning and Action

Process Consistent flow, robust quality and design, manage Total Customer experience at each stage

Progress Key data in context, visual analysis, kaizen improvement and planned approach to innovation

People People are the organisation, enable people to flourish, learn through teamworking

Tools and Methods that continue to be redefined